

**THE CLASSROOM IMPLEMENTATION OF INDIGENOUS
KNOWLEDGE IN THE SCIENCE CURRICULUM BY SCIENCE
TEACHERS IN THE WESTERN CAPE PROVINCE, SOUTH
AFRICA**

by

KEITH RONALD JACOBS

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DEDICATION

This study is dedicated to my son, Ashwen Clint Jacobs, who passed away in July 2013 during the final stages of my study. I am sorry that I will not be hearing “ARE YOU SERIOUS?” when he heard that I finished the thesis, but I am sure that he will be proud of his dad.

DECLARATION

I declare that **“The classroom implementation of indigenous knowledge in the science curriculum by science teachers in the Western Cape Province, South Africa”** is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

.....

Keith Ronald Jacobs

ABSTRACT

The South African policy document of the Revised National Curriculum Statement (RNCS) for Natural Science (Department of Education, 2002), the National Curriculum Statement (NCS) for Life Science (Department of Education, 2003), and the Curriculum and Assessment Policy Statement (CAPS) for Natural Science and Life Science (Department of Education, 2011) recognises and affirms the critical role of Indigenous Knowledge Systems (IKS) in science education. These policy documents expect the science teachers to integrate indigenous knowledge in their lessons. This study strove to establish how selected high school science teachers in the Western Cape Province responded to the inclusion of indigenous knowledge in their teaching.

The present study employed a multi-method approach, involving different research methods used in parallel or sequence but are not integrated until inferences are made (Johnson, Onwuegbuzie & Turner, 2007). This study took place in two main sequential data collection phases, namely, the quantitative data collection phase ((QUAN) and the qualitative data collection phase (qual). This contemporary approach was employed in order to provide credible and trustworthy answers to the following research questions, namely,

- 1) To what extent are the science teachers in the Western Cape Province integrating scientific and indigenous knowledge, as required by the Department of Education? If not, what are their reasons for this?
- 2) What are the teachers' views about and understanding of the nature of science and indigenous knowledge as well as their views on how the two worldviews can be integrated in the classroom?
- 3) How effective was the treatment in enhancing the teachers' ability to integrate science and indigenous knowledge in the classroom?
- 4) To what extent can the model of Snively and Corsiglia (2001) be useful for measuring change as the teachers implement the integration of indigenous knowledge in the science classroom?

For the QUAN phase, the researcher adapted a questionnaire and a new questionnaire, the *Nature of Indigenous Knowledge Questionnaire* (NOIKQ), was developed. The purpose of this questionnaire was to obtain a detailed description of high schools science teachers' understanding of scientific and indigenous knowledge, as well as the problems the teachers encounter in their implementation of Learning Outcome 3 of Life Sciences and Natural Science.

After the pilot study of the questionnaire and subsequent modifications to it, data were collected. Convenience sampling and purposeful sampling characterised the samples of respondents and schools. This sampling strategy ensured a total sample of 370 high school science teachers in 80 public schools, represented by urban and township schools in the Western Cape Province.

The results of the QUAN phase indicated that the teachers did not receive training on how to integrate science and indigenous knowledge, and that they did not have sufficient knowledge of indigenous knowledge to teach this aspect confidently to their learners. An inquiry was embarked on in order to train the science teachers in how to integrate indigenous knowledge in the science classrooms. A workshop was chosen as an intervention to improve the teaching skills of the teachers and to develop new methods of teaching. A quasi-experimental design was chosen to establish how effective the intervention was. In this quasi-experimental design, one group of five teachers was assigned to the intervention, whilst the other group of six teachers received no intervention at all. This intervention was based on the model of Snively and Corsiglia (2001) for integrating IK in the science curriculum. These teachers had participated in the survey and were selected for their particular interest in the research study.

Classroom observations and three teacher and six learner interviews were used for collecting qualitative data to establish the effectiveness of the intervention. A finding from this study is that the worldviews that the teachers bring into the classroom have implications for approaches they take to include IKS in their lessons. The results of the qualitative phase indicated that, given the teachers background (i.e., cultural, political and

social), teachers interpreted and implemented IKS in different ways in the curriculum. The teachers who attended the workshop and were trained to integrate indigenous knowledge in the science curriculum were more confident than those teachers who were not trained to integrate IK in the science curriculum. This increased confidence resulted from the workshop which enhanced the teachers' IK content knowledge and made them less dependent on the learners for examples of IKS.

The study offers important implications and recommendations to teachers and policy-makers regarding the implementation of the integration of IKS in the science curriculum, as well as fruitful avenues for further research.

Keywords: Indigenous knowledge. Indigenous knowledge systems, Western science, Natural Science, Life Science, Western Cape Province

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I would like to thank the WCED who gave permission to conduct the research in schools.

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LIST OF ABBREVIATIONS

ANC	African National Congress
ANOVA	Analysis of variance
C2005	Curriculum 2005
CAPS	Curriculum Assessment Policy Statement
DOE	Department of Education
EMDC	Education Management and Development Centres
FET	Further Education and Training
GET	General Education and Training
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
LO3	Learning Outcome 3
MC	Metropole Central
ME	Metropole East
MN	Metropole North
MS	Metropole South
NCS	National Curriculum Statement
NOIKQ	Nature of Indigenous Knowledge Questionnaire
NOSNIK	Nature of Science Nature of Indigenous Knowledge
OBE	Outcomes-Based Education
QUAL	Qualitative Data
QUAN	Quantitative Data
RNCS	Revised National Curriculum Statement
WCED	Western Cape Education Department
WMS	Western Modern Science

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CHAPTER 1

GENERAL INTRODUCTION

After the democratic elections in 1994, the South African education system was subject to fundamental and radical changes in the curriculum. South Africa adopted outcomes-based education (OBE) in order to ensure a more inclusive and quality education for all its learners (Jansen & Taylor, 2003). The new curriculum has affected a shift from one which has been content-based to one which is based on outcomes. The new curriculum strived to enable all learners to achieve their maximum ability by setting the outcomes to be achieved at the end of the process (Department of Education, 2002). The outcomes encourage a learner-centered and activity-based approach to education. One of the outcomes, Learning Outcome 3 of the Sciences (Natural Science as well as Life Sciences), expected the teacher to integrate indigenous knowledge in the science curriculum. Indigenous knowledge reflect the wisdoms and values that the people living in, for example, Southern Africa have acquired over centuries, and much of this wisdom is believed to have been lost in the last 300 years of colonisation (Department of Education, 2002). It is argued that integrating indigenous knowledge in the science curriculum will bring about social change in the society and promote justice and equity (Semali & Kincheloe, 1999). The present study aims to establish whether the integration of science and indigenous knowledge, as prescribed by the Department of Education, is occurring in the Western Cape Province of South Africa. Furthermore, if the integration is not being implemented, the present study endeavours to establish the reasons for the non-implementation, and to train the teachers so that they are equipped in integrating indigenous knowledge in the science curriculum.

1.1 Background and rationale

The history of modern science education in Africa is closely linked to its colonial past (Jegede, 1995; Jegede & Okebukola, 1989). Science and mathematics were not taught as school subjects in most of the colonial African countries until after independence. Before

independence, education was largely restricted to the provision of primary schooling in which science did not play a significant role. The science taught to the minority who attended secondary school was a reflection of that in the schools of the colonial master (Rollnick, 1998). Colonial education supplanted traditional education and was so greatly entrenched that it maximally served the interests of colonialism (Abdi, 2005). The colonial education led to the separation of individuals from their existential conditions and experiences, from their cultures and individuality (Giroux, 1996). According to wa Thiong'o (1986), the process of colonial education annihilated people's beliefs in their names, their languages, in their environment, in their heritage of struggle in their unity, in their capabilities, and ultimately, in themselves.

The colonial education devalued local indigenous knowledge as primitive, and taught learners to believe that they were inferior (Giroux, 1996; wa Thiong'o, 1986). Throughout the colonial years, school curricula in Africa were constructed within the white middle-class mainstream explanations of what constituted scientific phenomena, while indigenous knowledge was demeaned as common sense (Shizha, 2005). Despite the plea to have the colonized curriculum changed, the curriculum remained unchanged after independence (Abdi, 2005; Shizha, 2005). There were also very little shift from the Eurocentric definitions of official knowledge and school pedagogy, and the school curriculum was still very similar to European curricula (Shizha, 2005). Therefore indigenous voices were still, to a large extent, silenced and dominated, whilst Western knowledge was continuously visible in schools and in society.

The South African system of education is rooted in the country's scheme of apartheid. Cross and Chisholm (1990: 44) state that "racist attitudes and differential schooling for black and white have been an integral part of South African history since the beginning of settler occupation and domination of the territory." South Africa became the subject of apartheid education in 1948 when the National Party came into power. Apartheid education was a practice of maintaining the colonial British education system and of

preserving the master-servant relationship between the Africans¹ and the Whites. Until 1994, the apartheid government provided separate, racially divided education systems which were unequally funded (Fataar, 1997: 340). The former patterns of education systems were aimed at preparing South Africans for differentiated roles in the labour market and society (Kallaway, 1984). The split curriculum was also designed to equip black people for unskilled labour (Kallaway, 1984). It also failed to prepare many South Africans for a modern and democratic society because school subjects such as, for example, high school Mathematics and Science, were either omitted from their curricula in government schools, or were presented poorly by under-qualified teachers (Rollnick, 1998).

Since 1994, desegregation of the education system occurred in South Africa. African learners could and did now attend formerly White, Indian and Coloured schools (Meier, 2005). The schools have thus now changed from a monocultural context to a multicultural context. Teachers in South Africa are increasingly finding themselves in classrooms with learners from cultural backgrounds that differ from their own. A major aim of multicultural education is to create equal educational opportunities for learners from diverse racial, ethnic, social-class, and cultural groups (Banks, 1995). However, multiculturalism ignores and underplays the inequality in power between different cultures (Vandeyar, 2003).

In response to the post-1994 policies that mandated desegregation in South African schools, the former White schools' response to change was insufficient as a means to cope with the diversity of students and different approaches was adopted by these schools (Meier, 2005). Firstly, these schools adopted an assimilationist approach. The learners who are exposed to this approach were expected to adapt to the existing ethos of the school. The process of desegregation in those schools was simply a case of assimilating black learners into the school and its culture with the result that the *status quo* was kept

¹ The terms African, Coloured, White and Indian are the groupings that underpinned the political system of racial classification that characterised apartheid. The term black is used as a collective term to describe all people who were discriminated against under the apartheid system, and is sometimes used synonymously with the term African.

intact (Vandeyar, 2003; Meier, 2005). Secondly, the colour blind approach to the curriculum was another way in which schools maintained the *status quo* (i.e., former segregationist bias). What is implied in these colour blind practices is the belief that the newcomers come from educationally and culturally inferior backgrounds (Meier, 2005). Thirdly, the celebratory approach in which parents are often invited to a multicultural day at school and is a superficial ‘add on’ gesture which does little to bring about real unity in diversity (Meier, 2005).

Before 1994, the apartheid government was responsible for setting and developing education policy. The apartheid curriculum was described as: teacher-centered, content-based, privileged formal knowledge which encouraged rote-learning, produced passive non-thinking citizens, teachers were seen as technicians rather than professionals, required to teach to a prescribed syllabus and subject to inspections to ensure that they complied (Jansen & Taylor, 2003; Rogan, 2004). Since democracy in 1994, South Africa has had a number of curriculum reforms intended to redress the inequalities and injustices caused by the apartheid regime, using education as its tool (Chisholm, 2005; Jansen, 1998).

After 1994, when the democratically elected ANC government came into power, education was one of the first areas of reform and redress. Curriculum revision began immediately after the election. In 1997, the new National Department of Education launched *Curriculum 2005* (C2005). The National policy document (C2005) called for a curriculum that was learner-centered, holistic, unbiased, integrated, and relevant to develop critical citizens who can participate actively and responsibly in a democratic, multicultural society (Department of Education, 1997a). *Curriculum 2005* was informed by the principles of outcomes-based education (OBE) which involves the most radical form of an integrated curriculum (Department of Education, 1997b). The central aim of OBE is to shift from teacher-centered to learner-centered teaching and learning strategies (Cross, Mungadi & Rouhani, 2002) to foster critical thought and to focus on developing appropriate skills, by drawing on work that is relevant to the learner’s lives. The new curriculum called for the specification of discrete learning outcomes. These outcomes

reflected a major change in what was supposed to be learned in schools, emphasizing competencies, rather than particular knowledge (Cross et al., 2002; Howie, 2002; Jansen & Taylor, 2003).

The new curriculum was strongly supported within the ranks of the ANC and its allies (i.e., COSATU, SADTU), as well as a number of university education faculties (Jansen & Taylor, 2003). However, OBE is a complex educational model, and critical issues relating to its suitability as a reform strategy for South Africa was raised by teachers, university lecturers, as well as in published articles (such as Chisholm & Fuller, 1996; Chisholm & Leyendecker, 2008; De Clercq, 1997; Rogan & Grayson, 2003). Jansen (1998) provided several reasons why curriculum reform in the form of OBE would eventually fail. Jansen persuasively argued that OBE would fail because it was based on flawed assumptions about what actually happened inside schools, how classrooms were organised, and what kind of teachers existed within the system. Jansen (1998: 330) cynically concluded that it was important to understand “OBE as an act of political symbolism in which the primary preoccupation of the state is with its own legitimacy... and is primarily an attempt to push forward something innovative into the schools at all costs.” The curriculum reform, in the opinion of Jansen (1998) was not accompanied by a detailed plan of how these new ideas would be implemented in under-resourced classrooms.

The implementation of *C2005* was problematic. The implementation problem will be discussed in detail in Chapter 2 (page 17). In 2000 *C2005* was revised, leading to the launch of the Revised National Curriculum Statement (RNCS) and National Curriculum Statement (NCS), specific to each subject (Department of Education, 2002). The RNCS and NCS was not a new curriculum, but a modified *C2005*, with fewer curriculum design features and outcomes than *C2005*, and implementation guidelines (Howie, 2001). Ongoing implementation challenges as well as weaknesses of the National Curriculum Statements (i.e., RNCS and NCS), and the critique leveled against the new curriculum resulted in another review in 2009.

To improve implementation, the National Curriculum Statements were amended, with the amendments coming into effect in January 2012. The two National Curriculum Statements for Grades R-9 and Grades 10-12 respectively, were combined into a single document which was known as the *Curriculum and Assessment Policy Statements* (CAPS) for each subject (Department of Education, 2009). The CAPS document will be the definitive support for all the teachers and help address the complexities and confusion created by curriculum and assessment policy vagueness (Department of Education, 2009). In the CAPS document, Learning Outcomes do not feature, and was replaced by broad Subject Specific Aims.

When the present study commenced in 2006, there were three Learning Outcomes in Natural Science and Life Science. One of the Outcomes, Learning Outcome 3 (LO3), was problematic for the teachers. In the CAPS document, Learning Outcome 3 is replaced by Specific Aim 3, which relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science (Department of Education, 2011:13). Thus, Learning Outcome 3 is synonymous with Specific Aim 3 of CAPS, and throughout this thesis the term 'Learning Outcome 3' will be used.

The new South African science curriculum called on all science teachers to integrate school science with indigenous knowledge. This call has caused much controversy amongst stakeholders, especially the teachers, who were expected to implement a curriculum requiring a radically different instructional approach from the existing fact-orientated curriculum and were not equipped with the necessary instructional skills to implement the new curriculum (Jansen & Christie, 1999). This was a challenge to all science teachers in that the present teaching and learning materials included none or very few topics from indigenous knowledge.

The challenge of including indigenous knowledge in school curricula has been taken up in the National Curriculum Statement policy documents (2002, 2003) which mandate that elements of indigenous knowledge should be integrated in all learning areas/subjects. The

inclusion of indigenous knowledge in the South African curriculum policy statement is a positive step and could provide opportunities for debate on interaction(s) between western and indigenous worldviews. Effective learning, however, will depend on teachers' understanding of this interaction and their ability to manage classroom discourses related to this matter (Le Grange, 2007).

According to Hargreaves (2005), the most common and significant influences are the teachers' age as well as their stage of career. Sikes (1992) argues that teachers do not want to risk changing their own practice, which is rooted in practical knowledge that spans the course of their careers, especially if this known has proven workable. Rogan and Grayson (2003) assert that the process of change is context-specific and usually plays out differently in each and every school. Bantwani (2010) found that some South African teachers' prior knowledge and assumptions about reforms and their daily challenges plays a critical role in informing their learning and change process.

This the present study sets out to investigate the change in teaching practice by science teachers in the Western Cape Province from a teacher-centered approach to a learner-centered approach as identified by the new South African curriculum, as well as the implementation of the integration of indigenous knowledge in the science curriculum.

1.2 Problem statement

At the beginning of 2001, an outcomes-based approach to teaching and learning was implemented in Grade 8 in all South African public schools. According to Learning Outcome 3 of the Revised National Curriculum Statement for the Natural Sciences and the National Curriculum Statement for Life Science, traditional and indigenous knowledge should be integrated in the curriculum. However, the successful and effective integration of indigenous knowledge into science can only be achieved if teachers understand what integration of indigenous knowledge means, and have the ability to integrate indigenous knowledge in their teaching. It is against this background that the present study was conducted in order to establish whether teachers are able to implement

the integration of science and indigenous knowledge in science classrooms in the Western Cape Province. If the teachers are unable to integrate science and indigenous knowledge, the study further endeavours to enquire into the problems teachers encounter in their attempted implementation of indigenous knowledge into the science curriculum.

1.3 Aims and objectives

The aim of this study is to describe, analyse, and compare whether the integration of scientific knowledge and indigenous knowledge, as expected by current curricular reforms (Department of Education, 2002), is being implemented by high school teachers in selected school settings in the Western Cape Province of South Africa. Previous studies showed important associations between the learners' indigenous knowledge and the learning of science (Ogunniyi, 1988; Onwu & Mosimege, 2004). A further aim of this study is to equip teachers so that they have an adequate understanding of science and indigenous knowledge, and how science and indigenous knowledge could be integrated in the teaching-learning process with classes containing children with a diversity of local religious, cultural, and social belief systems. It is further hoped that this study will contribute to more effective science education in the Western Cape Province specifically, and in South Africa in general.

Objectives of the study with respect to the Western Cape Province are thus the following:

- a) To adapt and validate a questionnaire for investigating the science teachers' understanding of indigenous knowledge, as well as the problems they encounter when implementing LO3 in Natural Science and Life Sciences.
- b) To describe the science teachers' understanding of indigenous knowledge and scientific knowledge in both quantitative terms (i.e., using the questionnaire) and qualitative terms (i.e., using additional classroom observations and interview data).

- c) To provide indigenous knowledge resource material to the teachers, and specific interventions yielding successful integration of indigenous knowledge in the science curriculum, and
- d) To establish how successful the resource material was in assisting the teachers to integrate indigenous knowledge in the science curriculum.

The study will therefore seek answers to the following research questions with regard to the Western Cape Province:

- 1) To what extent are the science teachers in the Western Cape Province integrating scientific and indigenous knowledge, as required by the Department of Education? If they are not implementing the integration, what are their reasons for not doing so? (objective a)
- 2) What is the teachers' understanding of the nature of science and indigenous knowledge as well as their view on how the two worldviews can be integrated in the science classroom? (objective b)
- 3) How effective was the treatment in enhancing the teachers' ability to integrate science and indigenous knowledge in the classroom? (objective c and d).
- 4) To what extent can the model of Snively and Corsiglia (2001) be useful for measuring change as the teachers implement the integration of indigenous knowledge in the science curriculum? (objective c and d).

1.4 Significance of the study

Science teachers' implementation of the integration of indigenous knowledge and science is not fully understood and research on this is still on-going (Ogunniyi, 2006b; Ogunniyi, 2007a, 2007b; Ogunniyi & Hewson, 2008; Onwu & Ogunniyi, 2006). To attain a successful integration of the scientific and indigenous knowledge systems in the school curriculum, the teacher will play an important role. The researcher is not aware of any large scale study in the Western Cape investigating the implementation of the integration of indigenous knowledge and science.

In South Africa, studies of the implementation and the problems teachers encountered in the integration of IK and science have been conducted (i.e., Brown, Muzirambi & Pabale, 2006; Keane, 2008; Kyle & Kurz, 2006; Ogunniyi, 2005, 2006a; Ogunniyi & Hewson, 2008). This study is significant in that it focuses on practicing teachers in their classrooms and provides insights into particularly those individuals that will influence the implementation of the integration of IK in the science curriculum. Furthermore, it is anticipated that this study will document science teachers' current understanding of indigenous knowledge systems. This is especially important for teachers with multicultural classrooms.

Indigenous knowledge is not documented and is not readily available to teachers. Teachers have very little resource material to support them because the textbooks that are available to science teachers in South Africa did not include many cultural inclusions and activities (Naidoo, 2002). This study is significant in that well-researched curriculum material was developed and tested in workshops. Furthermore, it is anticipated that this study will contribute to the IKS science curriculum content by documenting some of the cultural knowledge obtained from the teachers as well as learners.

The policy document of the Department of Education (2002) acknowledges that there may be different worldviews present in the classrooms, as a result of rising diversity in South African classrooms. The worldview of the teacher plays an important role in the manner in which they approach the teaching of indigenous knowledge. It is anticipated that this study will contribute to the understanding of the implementation of the integration of IKS in the mainstream science curriculum.

1.5 Clarification of terms

In this study, key concepts are defined as follows:

Curriculum statement

Curriculum 2005 (C2005) was the new South African curriculum model introduced in 1998 which was based on the principles of outcomes-based education (Jansen & Taylor, 2003) and which was competency-bases (Taylor & Vinjevold, 1999). In 2000, C2005 was revised through the formulation of the *Revised National Curriculum Statement* (RNCS) for GET (Grade R-9), which was a simplified and clarified *Curriculum 2005* (Department of Education, 2011). In 2002, the *National Curriculum Statement* (NCS) for the FET phase (Grade 10-12) was developed (Department of Education, 2011). To improve implementation, the RNCS and the NCS was replaced by a set of single, coherent document per subject from Grade R-12, and was called the *Curriculum Assessment Policy Statement* (CAPS) Grades R-12 (Department of Education, 2011). The CAPS policy document came into effect in January 2012.

Science

Science refers to the subject Natural Science for Grade 8 and 9, as outlined in the Revised Natural Curriculum Statement (Department of Education, 2002), as well as the subject Life Sciences for Grades 10 to 12, as outlined in the National Curriculum Statement (Department of Education, 2002). Both Natural Science and Life Science is referred to because teachers of both these subjects will be used in the present study because the sample used in this study consists of teachers from Grade 8 to Grade 12.

1.6 Context of the study

One of the first priorities of the democratically elected ANC government was to reform the education system. Typical of other curricular reforms in Africa, the newly implemented curriculum was largely inspired by political rather than technical rationality (Ogunniyi, 2009b). The new curriculum required that indigenous knowledge be included in the curriculum. The schools and the curriculum should be made culturally sensitive and responsive to the needs and the aspirations of the African people (Ogunniyi, 1988).

The relevance and context of the new curriculum is important for motivating the learners. The section that follows will describe a curriculum relevant to all learners in South Africa.

1.6.1 Cultural relevance of the new curriculum

Many non-western learners struggle in science education at school because, firstly, science exists in a cultural context, and, secondly, teaching and learning science is often a cross-cultural activity (Cobern, 1996a). Socio-cultural knowledge arises not only from children's ethnic backgrounds but also from their socio-economic conditions, their environment, and the personal circumstances of their lives (Stears, Malcolm & Kowlas, 2003). There is evidence in the literature that the learners' background variables such as race, ethnicity, and home environment have a significant influence on their achievement in school science (Kesamang & Taiwo, 2002; Taiwo, Ray, Motswiri & Masene, 1999; Taiwo & Tyolo, 2002). Other factors that influence the learning of science are societal expectations, students' background, custom, and traditions (Akatugba & Wallace, 1999). The effects of socio-cultural factors on science education in classrooms have been well documented in a number of studies (e.g., Jegede, 1995; Jegede & Okebukola, 1989, 1991). These studies have concluded that the learners' socio-cultural background can prevent a proper learning and understanding of science.

There is a perception that the effective learning of school science and technology are linked to economic prosperity and that success in science can enhance the quality of life. However, researchers have shown that some ethnic minorities tend to underachieve and struggle in school science while others (e.g., Chinese minorities in western countries) can excel. Furthermore, African learners can experience science as a foreign culture (Jegede & Okebukola, 1991). This foreignness is because of the difference between the learners' worldviews (as determined daily from infancy by local culture and the environment) and the worldview of the scientific community (Costa, 1995; Jegede, 1995).

Some concepts of science that non-western learners learn in class are not familiar to them and have no relevance to their daily lives. According to the learners, they only hear the science concepts in the classroom but they cannot visualize them (Akatguba & Wallace, 1999). Newton (1988: 8) asserts that, “incorporating out-of-school experiences into teaching is commonly seen as having a strong motivational value and to hold promise for enhanced learning, retention, and recall of what has been taught.” Moreover, there is a high political value and appeal of teaching of science that does not alienate learners from their experiences, socio-economic environment, culture, norms, and societal value (George, 1999a; Jegede, 1995; Koosimile, 2004).

However, making science relevant to the everyday lives of children is a problem, and it may “require a variety of other factors, a classroom environment in which students can be actively involved in making meaning of the information within a relevant, real-life context” (Dass, 2001: 969). As the non-western learner interprets the science he/she is being taught, this interpretation will be influenced by prior knowledge. The educator must not expect the non-western learner to understand science in a manner similar to that of the learner from a western background. As Cobern (1996a: 305) puts it:

It is important for science educators to understand the fundamental, culturally based beliefs about the world that students bring to class, and how these beliefs are supported by students’ cultures, because science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students.

The learners also bring different worldviews to the classroom. Educators are confronted with learners whose worldviews are in conflict with scientific explanations. Non-western learners also bring many common superstitions to the classroom. The learners are then expected to construct meaningful scientific concepts, although the concepts conflict with the learners’ cultures (Aikenhead, 1997b; Cobern, 1996a; Jegede & Okebukola, 1991). According to some researchers, the African culture and African worldview can cause learners to fail to understand some aspects of school science (Aikenhead, 1997b), just as numerous westernised superstitions can cause First World children to fail to understand other aspects of school science. Learners from different cultural backgrounds often struggle to learn science.

There have been increased efforts in many countries (including South Africa) to include some aspect of indigenous knowledge in the formal science curriculum (Ogunniyi, 2009b). According to the national Department of Education, reasons for this inclusion have been based on the notion that school science did not adequately reflect the learners' socio-cultural environment. According to Ogunniyi (2009b), where attempts have been made to integrate science and indigenous knowledge (i.e., curriculum programmes designed for the North American Indians or the Aborigines of Australia) was not successful in distinguishing between the characteristics and the assumptions of science and those inherent to indigenous systems.

1.7 Overview of the thesis

The study is presented in five chapters. This chapter, which is an introduction to the study, provides the background and rationale, the aims and objectives, the problem statement, the context of the study, and an overview of the entire thesis.

In Chapter 2, a brief overview of the literature about *Curriculum 2005*, constructivism, multiculturalism, and a detailed literature review of indigenous knowledge, and the integration of science and indigenous knowledge will be provided. In the first part, an overview of the literature on curriculum reform is given. In the second part, a background of constructivism is given. Constructivism was the approach used in the implementation of outcomes-based education. A teacher who teaches from a constructivist viewpoint takes into consideration the learners' prior knowledge. The prior knowledge includes the traditional cultural knowledge that the learners bring into the classroom. In the third part, an overview of the literature on multiculturalism is given. The problems associated with multiculturalism are highlighted. Finally, the policy documents of the Department of Education state that indigenous knowledge should be integrated with scientific knowledge. Problems associated with the integration of science and indigenous knowledge is highlighted.

In Chapter 3, details related to the research methods used are presented, and a rationale is provided for the multi-method research design employed in this study.

In Chapter 4, the results and findings of this research study is presented in two parts. In Part A, results from the analysis of the quantitative data is reported. In Part B, the findings of the qualitative data collected by means of classroom observations and interviews are described.

In Chapter 5, the purpose of the study, as well as the research design is rehearsed. The limitations of the study are highlighted and answers to the research question are provided and discussed. The implications of the findings for education researchers, policy makers, and classroom teachers are stated. Recommendations for classroom practice, professional development programmes, and education policy makers are made, and concluding comments are provided.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, a review of the literature about *Curriculum 2005* (C2005), constructivism, multiculturalism, indigenous knowledge, and the integration of science and indigenous knowledge in the classroom, is provided.

In the first part of the chapter, a brief introduction on the state of curriculum reform in South Africa is given. The developers of *Curriculum 2005* hoped that the implementation of the new curriculum, alternative to apartheid education, would be completed by 2005 (Horsthemke & Kissack, 2008). However, difficulties were encountered with the implementation of this new curriculum. Teachers were not recognised and remained in the background. Policymakers at provincial and national level produced policy whilst the teachers only received policy (Smit, 2005). The teachers had to implement policies even though they are unlikely to have been involved in their formulation (Smit, 2005). Implementation must take the context of a particular school, such as its teachers; learners; leadership; and environment into account (Rogan & Grayson, 2003). Thus, throughout this thesis the problems of implementation will be interwoven in the discussions. The chapter starts with a brief outline of why a new curriculum was implemented in South Africa. Thereafter, the problems of the implementation of the new curriculum are discussed. Furthermore, the role of the teacher at the time of innovation and change during curriculum reform is discussed.

In the second part of the chapter, a brief explanation of constructivism is given. Constructivism was the approach used in the implementation of the new curriculum. For proponents of constructivism and outcomes-based education (OBE), the heart of OBE lies in its learner-centred character, as well as in its emphasis on bringing to the surface the local, hidden, silenced knowledge, and everyday realities of learners. This will influence the manner in which teachers will implement the curriculum reforms because

there are critics who maintain that education that is focused on the local, known, and everyday knowledge is not education.

In the third part of the chapter, a review of the literature on multiculturalism is given. Schools in South Africa were previously monocultural, but as a result of desegregation, the schools became multicultural. The problems associated with multiculturalism, as well as the effects of culture on education and classroom teaching and learning, is highlighted.

Lastly, the policy documents of the Education Department state that indigenous knowledge should be integrated with scientific knowledge. The implementation of curriculum requirements is the framework of this study. A critique of indigenous is given and problems with the integration of science and indigenous knowledge in the classroom are highlighted.

2.2 A brief introduction to the state of curriculum reform in South Africa

After 1994, when the democratically elected ANC government came into power, education was one of the first areas of reform and redress. Curriculum revision began immediately after the election. In 1997, the new National Department of Education launched *Curriculum 2005* (C2005). *Curriculum 2005* was informed by the principles of outcomes-based education (OBE) which “involves the most radical form of an integrated curriculum” (Department of Education, 1997b). The curriculum reform, in the opinion of Jansen (1998) was not accompanied by a detailed plan of how these new ideas would be implemented in under-resourced classrooms. The sections which follow will describe the implementation of the new curriculum.

2.2.1 Implementation of the new curriculum

The development of new curricula is a common event in countries across the globe. However, curriculum reform focuses on “what” shall be achieved, and “what” must be done, neglecting the “how” (Rogan, 2004). For curriculum change to occur, both the

“why” and the “how” must be addressed. Often the “how” is detailed and backed up by literature and worldwide experiences. However, because of the lack of focus on the implementation of the reforms, the actual and resulting accomplishments made in reality differ from initial intentions (The World Bank, 2008). The section which follows will firstly discuss how curriculum implementation occurred in South Africa, and secondly, the role of the teachers in South Africa at the time of innovation and change.

a) Implementation of curriculum 2005

Educational change may be implemented top-down or bottom-up. Top-down (or external) change rely on mandates, policy documents, external assessment, and other prescriptive methods, and is best for bringing about quick changes in schools and their structures (Macdonald, 2003). The kinds of change brought about by top-down implementation are superficial and transient in that they are made only to the extent needed to comply with policy and hence avoid possible sanctions and may therefore not be enduring. The kind of change brought about by bottom-up implementation is change that originates from within the school community itself, and is most effective in bringing about long-term, deep changes (Macdonald, 2003).

When it comes to implementing curriculum changes, the issues run very deeply. In developed countries with well qualified teachers and a multitude of factors favourable for change, successful implementation has proved difficult at the best of times (Clark, 2000). In South Africa, the education spans a range of contexts, from affluent First World, to impoverished rural Third World. There are some that boast magnificent buildings that would rank amongst the best in the world, whilst in contrast, there are those that occupy broken down buildings, lacking doors and windows, electricity and sanitation, and with few books and no resources (Rogan & Grayson, 2003).

Thus, implementation of the new curriculum needs to take the diversity of schools into account. However, according to Jansen and Taylor (2003), the cascade model of teacher training was chosen as the preferred model of preparing district officials and educators in

schools for the implementation of the curriculum where “a core of trainers at higher levels of the system would receive training and take this down through various levels of the education system until groups of teachers at a school were reached with knowledge about this new curriculum” and a one size fit all approach was assumed (Rogan & Grayson, 2003).

What were the main problems with the implementation of C2005? Several authors (e.g., Chisholm & Leyendecker, 2008; Cross et al., 2002; Howie, 2002; Jansen & Taylor, 2003) reviewed the literature to establish what the shortcomings were with the implementation of C2005.

Chisholm and Leyendecker (2008) examined the gaps between policy and practice in curriculum change. They argue that in practice ideas are recontextualised through multiple processes, displaced, and are often unable to meet the social development goals demanded from them. Jansen and Taylor (2003) as well as Rogan and Grayson (2003), argue that all schools and classrooms were treated as if they were the same, and did not take adequate account of the resource status of the schools and classrooms in South Africa. This led to the privileging of the better established schools. White schools had few problems implementing the curriculum change, since they felt that they had been teaching close to the intended instructional methodology for years, whilst Black schools appeared unable to implement the changed curriculum, because of a lack of resources and capacity (Chisholm & Leyendecker, 2008).

There was also inadequate professional development infrastructure. The mobilization of department officials, who themselves were inexperienced in curriculum reform, and with a weak knowledge base in the subjects, did little to strengthen school-based capacity for implementation (Jansen & Taylor, 2003). These trainers and Department officials themselves did not have firsthand knowledge of the kinds of curriculum and training that was envisaged, which led to a variety of interpretations (Howie, 2002; Jansen & Taylor, 2003).

The haste of implementation of the new curriculum was problematic (Chisholm & Leyendecker, 2008; Cross et al., 2002; Howie, 2002; Jansen & Taylor, 2003). The World Bank (2008) argues that not enough time was provided and not enough technical expertise was used, in the initial analysis and design of the curriculum, which resulted in a lack of clarity of the meaning of the curriculum reform. On the other hand, Jansen and Taylor (2003) feel that the lack of thorough baseline studies and the maintenance of national evaluation data sets to track the reform process and its implementation encouraged anecdotalism and discouraged in-process curriculum modifications. Furthermore, Jansen (1998) argues that curriculum reform and OBE is primarily an attempt to push forward something innovative to the school at all costs in order to reclaim political credibility, and as such has very little to do with bringing about substantive change to teaching and learning in the classroom.

According to Jansen and Christie (1999), the main reasons for the criticism of the new curriculum were also the critical lack of solid learning material base that supports the pedagogy and philosophy of this progressive curriculum, and the lack of confident and competent teachers to manage the curriculum.

The newly appointed second minister of education recognized the deficiencies in the design and content of C2005, and called for a review of the curriculum using a panel of distinguished academics, bureaucrats, and teachers, and was led by Professor Chisholm. The report of the review committee on C2005 was published with its conclusions. According to the review committee, the complexity and structure of the curriculum had compromised the implementation of C2005. According to Chisholm (2000), factors which negatively affected the implementation of C2005 included poor departmental support to teachers, weak support of teacher training, tight timelines, the lack of enough support materials, and the general lack of resources. The committee recommended that the curriculum be strengthened by streamlining its design features, simplifying its language, aligning curriculum and assessment, improving teacher orientation and training, learning support material, and provincial support (Chisholm, 2000).

Based on the task teams' recommendations, C2005 was revised, leading to the launch of the *Revised National Curriculum Statement Grades R-9* (RNCS) and the *National Curriculum Statement Grades 10-12* (NCS). The RNCS and the NCS was not a new curriculum, but a modified C2005 with fewer curriculum design features, fewer outcomes, clear guidelines to teachers on what to teach, and implementation guidelines (Howie, 2002). The RNCS and NCS became policy at the end of 2001.

Whilst there was positive support for the two policy documents, there was also considerable criticism of various aspects of the implementation of the two policy documents manifesting in teacher overload, confusion and stress, and widespread learner underperformance in international and local assessments (Department of Education, 2009). In July 2009, the minister of Basic Education appointed a panel of experts to investigate the nature of the challenges and problems experienced by teachers in their implementation of the RNCS and NCS, and to develop a set of recommendations to improve the two policy documents.

The recommendations of the panel of experts were that the two (National Curriculum Statements should be rationalized into a set of single coherent document. A single comprehensive *Curriculum and Assessment Policy* (CAPS) document was developed for each subject to replace Subject Statements, Learning Programme Guidelines, and Subject Assessment Guidelines in Grade R-12. Furthermore, the panel recommended that the CAPS document should be "clear, unambiguous, measurable, and based on essential learning as represented by subject disciplines" (Department of Education, 2009: 49). CAPS came into effect in January 2012.

Many researchers have been enquiring into teachers and policy (Crossley & Vulliamy, 1995; De Clerq, 1997; Jansen, 1997, 1999). It is undisputable that teachers are the key to the success in curriculum reform (Guskey, 1995; Spillane & Callahan, 2000). It would be irrational and naïve to expect teachers to accept educational reforms without any objections. According to Little (2001), when new curriculum reform proposals are presented to teachers, these proposals are subjected to interpretations which normally

result in the formulation of new meaning(s), which may or may not support the new curriculum, and this will have consequences why the reform is implemented in the classroom. The teachers' voice offers substance and deeper understandings of the complexities at the levels of policy implementations. The section which follows describes the role of the teacher in policy implementation.

b) The role of the teachers at a time of curriculum reform

As mentioned earlier, curriculum reform is inevitable and the development of new curricula is a common event in countries across the globe. However, research has shown that policymakers and politicians neglect implementation and tend to emphasize adoption (Rogan, 2003). Consequently good ideas are never translated into classroom reality and a great deal of time, money and effort may be wasted. One of the most significant lessons from curriculum development elsewhere in the world is that successful curriculum innovation hinges on teachers (Haney & McArthur, 2002; Van Driel, Bulte & Verloop, 2005), who are the key to interpreting policy visions (Smit, 2001).

Across all subjects, the highly prescriptive curriculum and system of authoritarian control which characterised apartheid education effectively discouraged the professional initiative of most South African teachers (Clarke, 2000). The Department of Education (1997b) acknowledges the central role that teachers will play in the implementation of OBE at the classroom level. However, what is forgotten is an acceptance that the introduction of any new curriculum poses a range of challenges to teachers with regards to the underlying assumptions and goals, the subject demarcations, the content, the teaching approach, and the methods of assessment (Newstead & Bennie, 1999). The difficulties that teachers face with introducing curriculum reform into their classroom have been documented by a number of researchers (Jansen, 1998; Rogan & Grayson, 2003; Chisholm, 2003, 2005).

One of the axioms with which policy analyst and formulators work is that there is a necessary and interminable discrepancy between the articulation of policy intentions and

the translation of these ideas into concrete practice (Horsthemke & Kissack, 2008). Furthermore, policy implementation is far more complex than policy initiation, and the gap between established educational practices and new education policy principles is vast (Crossley & Vulliamy, 1995).

The successful implementation of C2005 clearly places very significant demands in both the pedagogy and professional practices of teachers in the classroom. With regard to the professional practice, teachers will no longer use pre-determined curricula, supported by standard textbooks. Instead, teachers are expected to become curriculum developers, producing material to suit their context, with emphasis placed on the development of appropriate skills and attitudes (Gray, 1999). With regard to the issue of pedagogy, the teachers had to make a paradigm shift, moving away from a transmission mode of teaching to a constructivist model of learning. Research from elsewhere in the world has shown that teachers experience great difficulties in making the sorts of changes demanded by shifts towards learner-centered learning (Clarke, 2000).

Policy makers at national levels usually produce policy and schools and teachers remain in the background. Sikes (1992) supported the view that teachers have to implement policies even though they are unlikely to have been involved in their formulation. The teachers are required to modify what they do, to meet specifications laid down by policy makers who neither know the teachers or the contexts in which work (Smit, 2005). Without considerable teacher support and development, curriculum initiatives will invariably fail to be implemented as intended by the developers of policy (Bell & Gilbert, 1996; Fullan & Hargreaves, 1992).

The approach to curriculum development, where content is developed at one level to be implemented at another level, is problematic because it reduces the teacher to the role of a technician with the responsibility of pushing the designers' theories into practice. Implementation of policy places many demands on teachers in terms of knowledge, skills, and attitudes, which play a role in understanding the reforms (Bantwini, 2010;

Smit, 2001) and are interpreted from a personal, subjective frame of reference (Bowe, Ball & Gold, 1992).

The challenge lies in ways of actively involving practicing teachers more directly in the curriculum development process. Gitlin and Margonis (1995) argue that ways should be found to involve teachers in the reform process. Bantwini (2010) on the other hand argues that the quality of curriculum reforms on its own does not guarantee a successful reception by teachers, but the teachers' beliefs, values, and experiences play a vital role in the acceptance of the reform. Neglect of these issues creates frustration and sends out a message that the Education Department lacks concern about its teachers, and can aggravate the gap between conception and reality, between political symbolism and implementation, noted by Lemon (2004).

Introducing curriculum reform should not be the end of reform. For innovation to be successful, curriculum planners must actively engage in this process of supporting implementation, as well as to monitor implementation with care at each stage of the process, so that remedies may be applied periodically toward coping with unanticipated difficulties (Altricher, 2005). It is also important to check where the teachers stand in their understanding of the reforms. Bantwini (2010: 89) asserts that teachers develop understanding of reform based on their professional experiences accumulated over years. Therefore, it is crucial that that all teachers involved in the reform process maintain the same vision of the reform process, which may result in a group of teachers ending up in different reform destinations. A clear understanding of, and a good articulation of the new reform visions and goals by curriculum planners and Education Department officials, are likely to help create preferred meanings about the new reforms. In order to make sense of the problems teachers experience with changing their practice, it is critical that one develops a sense of the classroom and school world as they see it, for it is only then that one can begin to understand more of the meanings and framework of their actions (Clandinin, 1986).

2.3 Constructivism

In the previous section it was shown that that C2005 advocates the use of teaching methods to encourage a more learner-centered classroom (Department of Education, 1997a). Contemporary understandings of learner-centered education are based on the Vygotskian cognitive psychology. Learner-centered education acknowledges the way the mind works and main aspects are: knowledge is not transmitted but constructed in the mind of learners, learning is a process in meaning is developed on the basis of prior knowledge, and language influences culture and thinking (Chisholm & Leyendecker, 2008). The prior knowledge of learners is an area of contestation because it can become problematic if teachers ignore the prior knowledge and indigenous knowledge of learners. This aspect will be discussed in more detail in section 2.5.7. The section which follows will give an overview of constructivism with the related issues of learner-centeredness and prior knowledge of the learners.

2.3.1 Problems of constructivism and learner-centeredness in reform

Calls for constructivist classroom teaching practices are included in many reform recommendations around the world (Haney & McArthur, 2002). *Curriculum 2005* in South Africa also advocates the use of constructivist teaching methods to encourage a more learner-centered classroom (Department of Education, 1997a). However, constructivism is not a theory about teaching; but rather, it is a theory about knowledge and learning. The term constructivism has a wide spectrum of meanings and a conglomeration of different positions with varying emphasis, such as a pedagogic approach, a theory of learning or to indicate a philosophy (Tynjala, 1999).

Some constructivists describe the acquisition of knowledge as a building process in which knowledge is actively constructed by individuals or social communities (Brooks & Brooks, 1999; Taylor, Fraser & Fisher, 1997; Terhart, 2003; Terwel, 1999; von Glaserfeld, 1990). Other constructivists value the learners' prior knowledge during learning, as they believed that the learners' acquisition of new knowledge is influenced by their prior experiences. New information is passed through the filter of a learners'

prior knowledge and experiences (von Glaserfeld, 1990), and, consequently, what the learner already knows is important in the creation of meaning (Feltman & Downs, 2002). Von Glaserfeld (1995) draws inspiration from re-interpretation of Piaget's theory and developed a theory which is known as radical constructivism. According to radical constructivism, learning is a result of mental constructs in an individual's mind that materializes from an individual's interpretation of new experiences by drawing from an individual's past experiences (e.g. prior knowledge). A learner therefore uses old knowledge and experiences in the process of constructing new knowledge.

Constructivist theory acknowledges that the teacher is not a transmitter of knowledge, but rather a facilitator of learning. The teaching practices in the constructivist classroom also require that the learners must actively participate in the classroom activities, become more involved in the learning process, and take responsibility for their own learning. Therefore the learners are not absorbers of knowledge, but active participants in constructing their own meaning based on strongly held preconceptions (Aldridge, Fraser & Sabela, 2004). Driver and Oldham (1986), also acknowledged that what the learners bring with them to the learning situation is important and that active meaning is constructed as the individual interacts with the environment. Learners are responsible to construct their own meanings. In this way they make sense of new ideas by reconstructing the ideas for themselves, or to discuss it with more knowledgeable peers or receiving new explanations from the teacher. In this manner the learners gradually internalise what was one external (Scholtz, Watson & Amosun, 2004).

This research study concerns the implementation of learner-centered and outcomes-based education, which was part of the curriculum reform in South Africa. However, learner-centeredness is more than just an approach to teaching, it is a philosophy which guides the teachers' teaching and learning practice – how they teach, how they interact with the learners, how they design their courses, learning activities and strategies (McCown, Driscoll & Roop, 1996). This paradigm shift depends on changes in the role and work of the teachers who remain central to the instructional process. According to Appleton and Asoko (1996), attempts to introduce teachers to constructivist ideas are asking teachers to

change, not only views about learning, but also their classroom practices which result from them.

A question that can be asked is: to what extent are South African teachers prepared to face the imposition of this paradigm shift? A research study was conducted to elicit an understanding of what was involved when teachers were informed of the introduction of a new curriculum through new learning materials with very little support, and where they had little or no say in the key decisions (Nakabugo & Siebörger, 2001). The findings of this study showed that teachers will not change their style of teaching by simply informing them of the need for a change in style of teaching, and that teachers do not abandon one strategy for another, nor do they consistently use strategies which they accept as the better ones (Nakabugo & Siebörger, 2001).

Another aspect that must be considered is that this research study is located in science education. Scientific knowledge is constructed and communicated through the culture and social institutions of science (Driver, Asoko, Leach, Mortimer & Scott, 1994). However, such knowledge is unlikely to be discovered by individuals through their own empirical inquiries, but the science teacher is to mediate scientific knowledge for learners to help them to make personal sense of the ways in which knowledge claims are generated and validated (Driver et al., 1994). South African classes are multicultural (see section 3.3) and the African context must also be considered.

The constructivist classroom is one which maximizes learner's learning and consists of a programme of activities from which knowledge and skills can be constructed. In such a classroom, the 40-50 learners are not passive absorbers of information and the teacher is not the active transmitter of knowledge. In such a classroom the educator has an important mediating role. The educator should take into account the 40 different levels of what the learners already know, maximize social interactions between the learners so that they can negotiate meaning and provide a variety of sensory experiences from which learning is built (Tobin, Tippins & Gallard, 1994).

The learners' learning is influenced by socio-cultural factors. An increasing body of research points to the importance of the learners' socio-cultural knowledge and purposes which arise not only from the children's ethnic backgrounds, but also from socio-economic conditions, their environment, and the circumstances of their lives (Cobern & Aikenhead, 1998; Kesamang & Taiwo, 2002; Linkson, 1999; Ogunniyi, 1988). Another factor that influences the learning of science is societal expectations, students' background, custom, and traditions (Akatugba & Wallace, 1999). It is the contention of several researchers (Jegede, 1994; Jegede & Okebukola, 1991; Ogunniyi, 1988) that socio-cultural factors play a significant role in science learning in non-western cultures and recognise that the learners' socio-cultural background may serve as an impediment to fruitful learning of science (Kesamang & Taiwo, 2002).

Many non-western learners struggle in science education at school because "first, that science exists in a cultural context and, second, that teaching and learning science is often a cross-cultural activity (Cobern, 1996a). Some concepts of science that non-western learners learn in class are not familiar to them and have no relevance to their daily lives. According to the learners, they only hear the science concepts in the classroom but they cannot visualize them (Akatugba & Wallace, 1999). However, making science relevant to the everyday lives of children is a problem, but it may "require a variety of other factors, a classroom environment in which students can be actively involved in making meaning of the information within a relevant, real-life context" (Dass, 2001: 969). As the non-western learner interprets the science he/she is being taught, this interpretation will be influenced by prior knowledge. The teacher must not expect the non-western learner to understand science in a manner similar to that of the learner from a western country understands science. It is reasonable to expect culture-specific understandings of science (Cobern, 1996a). One should not expect African students to understand science exactly the same way students in western countries understand science. It is important for science teachers to understand the culturally based beliefs about the world that the learners bring to the class, and how these beliefs are supported by the learners' cultures (Cobern, 1996b).

Knowledge, contents, abilities, and so on is constructed. Whilst an individual's knowledge is personally constructed, the constructed knowledge is socially mediated as a result of cultural experiences and interactions with others in that culture (Stears et al., 2003). However, this construction does not start at zero, but always has its basis in an already existing knowledge structure. This existing knowledge is the starting point for any interpretation of the process of information that lead to learning as a construction of knowledge (Terhart, 2003). Other researchers (e.g., Driver, 1989; Driver & Oldham, 1986) concur with Terhart (2003) and say that the learners do not come to classroom as empty vessels to be filled. The learners therefore come to the school with a great deal of knowledge, termed prior knowledge, which determines the reception or processing of information when they experience school lessons (Grayson, Anderson & Crossley, 2001). An application of constructivism is that, for teaching to be effective, the learners' prior knowledge must be taken into account.

According to constructivism, new knowledge is constructed from old. The question that can be asked is: How can learners construct new knowledge from their existing concepts if their existing concepts are faulty or flawed? Prior knowledge therefore appears to be simultaneously necessary and problematic (Roschelle, 1995). Teachers are often faced with a paradox. On the one hand there are those teachers who firmly believe in constructivism where they must create experiences where learners must be actively engaged in making sense of concepts themselves and construct their own knowledge. On the other hand research tends to characterize prior knowledge as conflicting with the learning process (Roschelle, 1995). It is impossible to learn without prior knowledge, and there is widespread agreement that prior knowledge influences learning, and that learners construct new concepts from prior knowledge (Roschelle, 1995).

Roschelle (1995) has reviewed the literature of a number of studies of students' prior knowledge in the sciences and mathematics have been conducted for the last 40 years. Results of these studies conclude that new knowledge does not replace prior knowledge. However, prior knowledge is refined and placed in a more encompassing structure. Prior knowledge affects how learners interpret instruction and may frequently lead to

unacceptable and unconventional explanations thereof. The teacher must be aware that the learners are more likely to construct an interpretation that agrees with prior knowledge, and consequently disagrees with the viewpoint of the educator (Roschelle, 1995).

According to Jegede (1999b), there is a strong relationship between prior knowledge and the socio-cultural environment of the learner that conventional schooling too often ignores the influence of culture on what is learned at school, and that learners' prior understanding can often lead to quite unintended interpretations of what is being taught. Atwater (1994) also supports the view that that students' prior knowledge, expectations, and preconceptions serve as filters for information. Teachers must be aware that sometimes prior knowledge may actually hinder the learning process because some of the experiences are misconceptions in the scientific realm of thinking and practice.

Learners come to the classroom with their own ideas about the natural world and are likely to have their own understanding of natural phenomena (Driver et al., 1994; Driver & Oldham, 1986). These preconceived ideas are sometimes unscientific although they make sense to the learners. Constructivism seems to dictate that the teacher must take the learners' existing ideas (prior knowledge) into account when planning science teaching activities. What if the learners' understanding of natural phenomena is wrong? Many learners retain erroneous 'common sense' or everyday understandings of a number of scientific phenomena. Teachers must also be sensitive to how other cultures explain the natural world.

In the previous sections it was explained how learners construct their knowledge. Construction of knowledge, even scientific knowledge, is contingent on access, accuracy, analysis, and application of information (Gay, 1995). Many classrooms around the world, even in South Africa, are becoming increasingly multicultural. In such classes, many learners are members of marginalized or oppressed groups, and are many times considered intellectually inferior when it comes to scientific reasoning. The sections

which follow will highlight multiculturalism in South Africa after democracy, and the problems associated with multiculturalism.

2.4 Multiculturalism

Prior to 1990, schools in South Africa were characterized by racial segregation, and the provision of separate schools for separate racial groups was justified by the Apartheid Government (Carrim, 1998). In 1990 White schools were allowed to enroll Black learners legally, and the schools were given three desegregation modules to choose from, namely, Model A, which allowed the school to close down and reopen as private schools, Model B, which allowed them to remain open but with an open admissions policy, and Model C, where the salaries of the teachers would be paid by the state, and all other operational expenses must be borne by the school community (Carrim, 1998). However, by 1992 all previously white-designated schools were converted to Model C schools (Carrim & Soudien, 1999). Since 1993, traditional White schools became accessible to all population groups (Naidoo, 2000).

As a result of the desegregation of schools, there was an increase in the cultural and linguistic diversity of learners. Therefore some schools in South Africa changed from a monocultural context to a multicultural society context. Multicultural education sets to create equal educational opportunities for students from diverse racial, ethnic social-class, and cultural groups (Banks & Banks, 1995). Multicultural education attempts to help all learners to acquire knowledge, attitudes, and skills needed to function effectively in a pluralistic society and to interact, negotiate, and communicate with people from diverse groups in order to create a civic and moral community that works for the common good (Banks, 2001). Multiculturalism is based on the premise that racism, as a result prejudice and ignorance, can be eradicated by merely promoting personal contacts, cultural exchange, understanding, and provision of information.

Multiculturalism is often characterised as a means to transform society by means of a culturally-responsive curriculum and instruction. A multicultural approach emphasizes

the inclusion of content, role models, and examples of disparate cultures so that learners expand their perspectives and develop self-esteem (Tiedt & Tiedt, 1986). The aim of multicultural education is to bring tolerance and harmony between different cultures, but it ignores the fact that all cultures do not enjoy equal status in the society. Multicultural education, as currently being practiced both here in South Africa and overseas, has little hope of enhancing the life chances of children from black groups, because multiculturalism ignores issues of power, social class, the economy, and politics (Vandeyar, 2003). Multicultural education is seen as a solution to prejudice and discrimination attributed to ignorance and a lack of knowledge of other cultures. Tator and Henry (1991: iii) stated:

Multicultural education ... provides only a veneer of change rather than a transformation of educational processes and institutional structures. The most pressing challenge is a recognition and response to the racial barriers which permeate the educational process, impacting upon the curriculum, assessment and placement, hiring and promotion practices and the 'ethos' of the school environment.

Multiculturalism must be justified in moral terms (e.g., in terms of respect for persons and their cultural values and traditions) and this obligation is a universal one insofar as it applies to all students and science teachers (Siegel, 1997a; Siegel, 1997b; Siegel, 1999). Transforming science education into a multicultural practice is a loaded objective (Stanley & Brickhouse, 1994). The advantages of multicultural education remain debatable. On the one hand, some scholars criticised the inability of multicultural education to bring about significant structural reform and address deep-seated racism in society, or argue that the problem with multicultural education is that it does very little to address the existing social and cultural imbalances in South Africa (Cross & Mkwana-Twala, 1998). The learners in South Africa experienced assimilation and that the minimal type of multiculturalism introduced by teachers in schools was at best stereotypical, and at worst caricatured (Carrim, 1998; Carrim & Soudien, 1999; Meier, 2005).

Many researchers have studied the effects of culture on education systems and classroom teaching and learning (e.g., Fisher & Waldrup, 1997; Hodson, 1992; Jegede, 1999a; Jegede & Okebukola, 1991). The results of these studies have shown that the teaching

and learning process are influenced by the cultural values of both the teacher and the learner. Teachers must therefore know the cultural diversity of their learners before they can cope with 300 learners daily from different cultures to produce optimum learning. However, many teachers are believed to be unsuccessful in multicultural classes because they have a limited knowledge of the history and culture of the learners (Atwater, 1994). For the non-western teacher who shares the same non-western socio cultural background as his learners, the issue of teaching science is frustrating. However, the situation is even more difficult for the educator with a western background who has to teach learners from non-western backgrounds (Atwater, 1994; Jegede, 1994). It is important that the teachers in multicultural classrooms with learners from non-western backgrounds should first recognise the traditional indigenous base of the learner. The section which follows describes the influence of culture on science education.

2.4.1 Multiculturalism and a cultural perspective of science education

What is meant by the term *culture*? Culture has been defined by many researchers using different aspects of culture, for example, social and cognitive, in order to highlight a particular interest in cross-cultural or multicultural education (Aikenhead, 1996, 1997a; Cobern & Aikenhead, 1998). Culture, according to Geertz (1973: 5), means “an ordered system of meaning and symbols, in terms of which social interaction takes place.” However, Phelan, Davidson, and Cao (1991), give more specificity to Geertz’s definition of culture, as the norms, values, beliefs, expectations and conventional actions of a group. Science is embedded in, and influenced, by society and culture because scientific knowledge is socially constructed (Aikenhead, 1997b; Cobern, 1996b). School science is closely aligned to the subculture of science. Science learning is culture acquisition. However, the effectiveness of learning science is closely related to the congruence between the worldview of the family and friends of the learner on the one hand, and the scientific worldview on the other hand (Aikenhead, 1997b). The main goal of school science is cultural transmission of the subculture of science, as well as the cultural transmission of the country’s dominant culture (Cobern & Aikenhead, 1998).

Stanley and Brickhouse (1994:384) argue that science teachers need to question “Whose knowledge are we teaching?” and “Whose knowledge is most worth?” All knowledge is performative and representational (Turnbull, 1997). Le Grange (2007) argues that the situated messiness of science is not learnt and science is viewed as representation to the neglect of science as performance. Furthermore, in representations of Western science and indigenous knowledge, Western science is often portrayed as superior, universal and not having the “cultural fingerprints” that appear to be much more conspicuous in other knowledge systems (Gough, 1998: 508). Also, representations of Western science are used to declare other knowledges as non-science (Le Grange, 2007). A view of knowledge as representation produces a view that Western science and indigenous knowledge is incompatible or that indigenous ways of knowing may be recognised as a particular way of understanding the world, but that they are not science (Le Grange, 2007).

A common element of all knowledge systems is their localness (Turnbull, 1997). However, their differences lie in the way they are assembled. Turnbull (1997: 553) focus on the localness and performance of culture of culture and knowledge argues it to be a process of “making connections and negotiating equivalence between the heterogeneous components while simultaneously establishing a social order of trust and authority resulting in a knowledge space. It is on this basis that it is possible to compare and frame knowledge traditions.” Understanding knowledge production as performance enables seemingly disparate knowledges to work together so as to produce new knowledge spaces, is dependent on the creation of “a third space, an interstitial space, a space in which local knowledge traditions can be reframed, decentered and the social organisation of trust can be negotiated (Turnbull, 1997: 560).

Turnbull (2000: 228) means of comparing knowledge “where contrasting rationalities can work together without the notion of a single transcendent rationality” creates room to facilitate recognition and opens possibilities for the coproduction of knowledge. If knowledge is recognised as both representational and performative it will be possible to create a space in which knowledge traditions can be performed together (Turnbull, 1997).

When the worldviews and the cultures of the learners differ from that which is represented in their school science textbook, educational clashes will occur in science classrooms (Allen & Crawley 1998; Baker & Taylor, 1995; Jegede, 1995; George, 1999a; Ogunniyi, 1988). For many non-western learners, as well as for western learners, the learning of school science is a foreign culture because their worldview conflict in various ways with formalised western science. However, according to Aikenhead (1997b) and Costa (1995), Western science taught in schools does not seem like a foreign culture to non- western learners only, but also for many western learners. The more a learner's home culture differs from the formalised culture of Western science, the more the severity of the clashes for these students will increase. The learning of school science for many learners is a cross-cultural event.

A cross-cultural approach to teaching science for non-western learners is suggested because of cultural differences between the learners and school science (Jegede, 1995). Success in school science will depend on how effectively learners move between their life-world culture and the culture of school science. Jegede and Aikenhead (1999) found that learners' success in science education depended on: firstly, the degree of cultural difference that pupils perceived between their life world and the science classroom; secondly, how effectively learners moved between their life world culture and the culture of school science; and thirdly, the assistance learners received in making those transitions easier. A cultural perspective of science education recognizes the fact that an officially prescribed curriculum of school science is an attempt by curriculum planners and textbook writers to transmit the culture of Western science to all learners. However, cultural transmission can be either supportive or disruptive to learners (Aikenhead, 2006). The cultural functions of school science have traditionally been to enculturate or assimilate students into the subculture of school science. Many students resist assimilation and instead play a game called *Fatima's rules*. If students find a scientific content useful in their everyday life, they borrow or adapt it in a process called acculturation (Aikenhead, 2006).

Many researchers have studied the effect of learners' socio-cultural backgrounds on the teaching and learning of science, as well as how it appeared to influence achievement (Cobern & Aikenhead, 1998; Ogawa, 1986; Ogunniyi, 1988). Most of the researchers recognized that the learners' socio-cultural backgrounds have served as an impediment to the fruitful learning of science (Khine & Fisher, 2004). However, an alternative explanation may have been the paucity of skilled and effective classroom science teachers caused by low salaries; better job offers elsewhere, etc. According to Stears et al. (2003), the socio-cultural knowledge and purposes of learners include factors related to the learners' ethnic backgrounds, socio-economic conditions, the environment and the circumstances of their lives (e.g., poverty, family/support structure). All of these factors apparently had an influence on the learners' meanings and understandings of science for use in their everyday lives. For Jegede and Okebukola (1991), on the other hand, socio-cultural factors were deemed to be characterised by common values and appreciation of beliefs, myths, etc. The implications of the findings for teachers are that the specialists who design any western science curriculum in a non-western classroom environment may have to take the traditional worldview of the learner in consideration. According to Baker and Taylor (1995: 698), "it is educationally unsound to present science education to non-western students without careful consideration of the traditional mores and perceptions through which they are likely to interpret phenomena."

Teachers do not want to teach Western science to non-western learners and to assimilate the learners into Western science at the expense of diminishing the learners' cultural identities (Baker & Taylor, 1995). Teachers, therefore, are not always aware of the size of the cultural gap which exists between the western and non-western interpretations of reality. Teachers should be aware that learners do not come to the science classroom with *tabula rasa* minds. In the African context, learners come to the classroom with a worldview which may not be scientifically correct as a result of their cultural backgrounds. Therefore teachers should make a concerted effort to identify those elements of the learners' cultures which differ with the scientific culture, and to treat the elements of the learners' culture with the appropriate care they deserve (Kesamang & Taiwo, 2002). Teachers are faced with the problems of worldviews that learners bring to

the classroom and which provide explanations that are in conflict with western scientific thought. According to the study of Allen and Crawley (1998), the worldviews that the learners bring into the science classroom may affect, not only how they make sense of scientific information, but also the extent to which they are willing to participate in the educational experience, the feeling of outsiders (guests) in the science classroom. According to Jegede and Okebukola (1991), the learners' socio-cultural backgrounds which they bring to the classroom may cause a pedagogical wedge between what the teacher teaches and what they learn. Furthermore, if the socio-cultural background of the learner is indifferent to the learning of science, the learner may find it difficult or perhaps impossible, to learn science effectively.

The debate in the literature is dominated by publications in favour of multiculturalism, but teaching practice in science education remains unchanged. The classroom practice appears to remain based on the traditional western view of the nature of science and science education (Aikenhead, 2006). The apartheid government's education policy was grounded in a western modernist epistemology with the notion of the superiority of western science and the inferiority of indigenous knowledge.

It was shown in the previous section that schools in South Africa changed from a monocultural context to a multicultural society context. South Africa's new education system, outcomes-based education represents the country's commitment to promoting the principles enshrined in the Constitution, and catering for the full potential of learners of all cultural groups (Department of Education, 2002). IKS was introduced to schools in South Africa in 2001 and 2002 as mandated and strengthened through the RNCS (Natural Science and Technology) and the NCS (Life Sciences and Physical Sciences). Whilst the use of indigenous knowledge in the teaching of science is strongly advocated (Maurial, 1999; Jegede, 1999a; Semali & Kincheloe, 1999), the process of using indigenous knowledge in the classroom is not a simple one. The sections which follow will describe what IK is, the difference and similarities between IK and Western science, the integration of IK into the science curriculum, and the problems associated with this integration.

2.5 Indigenous knowledge

What is indigenous knowledge? The term indigenous knowledge has gained prominence in recent years and refers to bodies of knowledge developed by peoples with extended histories of interaction with the natural environment. The term “*indigenous*” has many meanings, for example: traditional ecological knowledge (TEK), local knowledge, ethno science, folk science, indigenous science, traditional science, and folklore (Williams & Muchena, 1991). In a similar manner, the term *knowledge* has different meanings to different people. Therefore, a combination of the two words, namely indigenous knowledge presents a huge task to present a single concept. The meaning of indigenous knowledge is difficult to pin down (Maurial, 1999).

2.5.1 Definition of indigenous knowledge

It is difficult to agree on a legally and scientifically acceptable definition of indigenous knowledge. Defining IK is problematic because there is no universally accepted definition of the term, and because many analysts are uncertain who should be talking about this term (Semali & Kincheloe, 1999). A review of the literature shows that indigenous knowledge has been defined by various researchers (i.e., Dei, 2000a; Mwadime, 1999; Odora-Hoppers, 2002; Ogunniyi, 2009b; Onwu & Mosimege, 2004; Semali 1999a; Semali & Kincheloe, 1999; Warren, 1991). However, none of the researchers define the term indigenous knowledge comprehensively, and several descriptions are afforded. What emerges from the definitions is that some researchers link indigenous knowledge that arise locally (i.e., Ogunniyi, 2009b; Semali & Kincheloe, 1999), the long term occupancy of a place (Dei, 2000a), or link the term with colonialism and indirectly focus on the differences between the two worldviews, namely Western science and indigenous knowledge (i.e., Mwadime, 1999). The section that follows will explain Western science and indigenous knowledge and highlight differences between the two concepts.

2.5.2 Indigenous knowledge and Western science

Indigenous knowledge and Western science have many similarities as well as differences between them (Aikenhead, 1997a; George, 1999a; Jegede, 1995; Snively & Corsiglia, 2001). Indigenous knowledge and Western scientific knowledge are neither completely different nor entirely the same, but display both commonalities and differences. Western science is often portrayed as superior, universal, and as not having the ‘cultural fingerprints’ that appear to be much more conspicuous in other knowledge systems (Gough, 1998). Representations of Western science are used as criteria for declaring ‘other’ knowledges as non-science. This perspective of knowledge produces a perspective that indigenous knowledge may be recognised as a particular way of understanding the world, but that it is not science (Le Grange, 2004). Traditional Ecological Knowledge (TEK) tends to be associated with the diversity of knowledge innovations and practices that indigenous communities hold, and is also often defined in opposition of Western, modern scientific conceptions of knowledge (Reid, Teamey & Dillon, 2002).

Indigenous knowledge and Western science are similar in that they rely on empirical evidence gathered by experimentation (Aikenhead, 2006; Emeagwali, 2003). According to Aikenhead (2006: 113), “experimentation can take place over many generations ... and it relies on natural changes rather than on laboratory manipulations.” However, the manner of knowledge acquisition in modern Western science is in an abstract manner (Studley, 1998). Both indigenous knowledge and Western science shows convergence in the fact that the physical universe can be understood by rational empirical means (Aikenhead, 2006). A characteristic shared by indigenous and Western knowledge is their localness, for example, their manifestation or expression in parochial or immediate contexts (see Shapin, 1994; Turnball, 2000). Another similarity between indigenous knowledge and Western science is that “both local knowledge and science are based fundamentally on observations of the outside world which are in principle intersubjectively accessible and communicable, in other words, they are not simply statements of faith (Antweiler, 1996).

After surveying research that has been conducted on indigenous knowledge, Agrawal (1995a) came to the conclusion that there are differences between the two knowledge systems. Firstly, the two systems differ on substantive grounds, because of the differences in the subject matter and characteristics of indigenous knowledge and Western science. Secondly, the two systems differ on methodological grounds, because the two forms of knowledge employ different methods to investigate reality. Thirdly, the two systems differ on contextual grounds because traditional indigenous knowledge is more deeply rooted in its environment.

However, Agrawal (1995b) is of the opinion that the distinction between indigenous and Western/scientific knowledge can present problems for those who believe the importance of indigenous knowledge for development. Furthermore, “only when we move away from the sterile dichotomy between indigenous and Western, or traditional and scientific knowledge, that a productive dialogue can ensue which focuses on safeguarding the interests of those who are disadvantaged” (Agrawal, 1995b: 5).

There are fundamental difference between indigenous knowledge and scientific knowledge : firstly, scientific knowledge seeks information which is not context-bound, whilst indigenous knowledge seeks information which is context bound; secondly, indigenous knowledge proceeds from observations gained through trail-and-error, as opposed to controlled experiments in Western science; thirdly, indigenous knowledge and Western science differ in their social goals as well as their means of gaining knowledge; and lastly, indigenous knowledge is generated through observations and experiment of uses whilst Western science is learnt in an abstract manner (Antweiler, 1996).

There are also other differences. Western science present science based on a mechanistic worldview, whilst indigenous knowledge, on the other hand, presents essentially an anthromorphic worldview (Jegade, 1995; Ogunniyi, 1988). Indigenous knowledge is holistic whilst Western science is reductionist (Aikenhead, 1997c; Ogunniyi, 2009b).

Western science breaks down data into smaller elements to understand the whole and complex phenomena. Western science distinguishes science into zoology, botany, physics, chemistry, etc. and this does not exist in indigenous knowledge. Indigenous knowledge views ideas and practices as one (Maurial, 1999; Mwadime, 1999). Learning in IK is communal, whilst in Western science learning is an individual enterprise (Jegede, 1999a: 125; Semali, 1999: 103). The manners in which the two systems are transmitted also differ. IK is basically transmitted through oral tradition whilst western science uses written records (Semali & Kincheloe, 1999). Maurial (1999: 63) describes this transmitting through oral traditions as *agrapha*, “not written down [directly].” Indigenous knowledge is based on observations of the natural world coupled with direct experimentation in the natural setting. Western science is conducted in laboratories (Kawagley, Norris-Tull & Norris-Tull, 1998).

Comparing Western science and indigenous knowledge reveals that IK is multifaceted and can pertain to knowledge systems of indigenous people and minority cultures. IK is culture defined and is built by a group of people living in a specific area and occurs over generations of living in close contact with nature. Indigenous knowledge is orally transmitted, and is cumulative and dynamic, building upon the experience of earlier generations. The section which follows gives a critique of IK.

2.5.3 Critique of indigenous knowledge

There has been an increased effort to include some aspects of indigenous knowledge in the mainstream science curriculum. Mwadime (1999) asserts that indigenous knowledge should not be presented as devoid of any shortcomings and has to be modified and adapted so that it can effectively function within the contemporary practices and social reality. According to George (1999b), indigenous knowledge is not included in most school curricula. The main reason is that indigenous knowledge is not normally ‘packaged’ as school materials are, for example science is compartmentalised into different learning areas, such as mathematics, botany, etc. The teachers therefore are not trained to “handle” indigenous knowledge in the classroom because they must first access

the indigenous knowledge, then understand it and devise teaching strategies to use it effectively. According to Mkosi (2005), the implication of this statement could be that teachers would have to be indigenous and creative if indigenous knowledge was to be implemented in the classroom. Also, it would be costly to produce teacher training materials.

Reynar (1999), on the other hand, asserts that when indigenous knowledge contributes to the cause of development, then it is viewed as having value. However, when indigenous knowledge does contribute to the cause of development, then it is labeled as irrational, misguided, or empirically unverifiable. Reynar (1999) then goes on to say that if indigenous knowledge is seen merely as one of the constituent bricks in the development process, then indigenous knowledge itself is reduced to a resource that can be exploited for economic growth. Mwadime (1999) on the other hand raises the awareness to the fact that indigenous knowledge may be beneficial to the economically and politically underprivileged. He also claims that indigenous knowledge may be less effective for the long term planning due to its vulnerability to changes.

Authors, for example Shiva (2000) and Ogunniyi (2009b) have presented unanswered concerns that are related to the epistemology and practices of indigenous knowledge, such as: Who will decide what counts as knowledge? Who will count as the expert or innovator of indigenous knowledge? Who will have the right to control the circulation of knowledge and who will have the right to benefit from it? The debate has even gone further to challenge the very process used in selecting what is to be taught, what counts as valid knowledge, and how such knowledge should be produced and shared (Dei, Hall & Rosenberg, 2000). There are also other concerns which include: What are processes of knowing and validating knowledge? Which knowledge is suitable for whom? Who produces the boundary between the canonical school science for instance and indigenous knowledge systems prevalent in the socio-cultural environment of most learners (Ogunniyi, 2009b)? Semali & Kincheloe (1999) also ask similar questions such as: How is knowledge produced in an indigenous community? Is there a role for indigenous knowledge in the academy? In what ways can indigenous knowledge be integrated in the

academy without devaluing one system over the other? Does culture have anything to do with how knowledge is produced in the academy?

No satisfactory answers have been found to these and similar questions. However, for indigenous knowledge to occupy a meaningful position in the academy, and as a possible instrument to alleviate the hardships of the poor and marginalised, the preceding concerns should be seriously interrogated for possible solutions. According to Dei (2000b: 79), indigenous knowledge holds significant possibilities for social and ecological sustainability because “ecological unity focus on the responsible use of land and natural resources according to the principles of sustainability” (page 79). George (1999b) also notes that indigenous knowledge could play a worthwhile role in environmental management. Indigenous knowledge could also educate the exploiters of natural resources how the environmental integrity should be respected, honoured, and valued. According to Semali (1999b), indigenous knowledge could make a significant contribution in cultural revaluing among indigenous peoples. Semali (1999b) calls for a more inclusive reconceptualized curriculum practice which is inclusive, democratic, and one which acknowledges African heritage, experience, identity, and history. Mkosi (2005: 95) concurs with Semali (1999b), and states that the inclusion and revival of “indigenouness” in the curricula, policies, and practices of societal institutions may have profound effects on the spirituality of the poor.

IK Notes (2000) claims that the educational reforms that have been taking place in Africa have generally created space for a new curriculum, and an indigenous curriculum may come to utilize this space. Williams and Muchena (1991) insist that indigenous systems could contribute to sustainable agricultural education. Quiroz (1999) claims that the inclusion of indigenous knowledge could make many curricula relevant to students and might equip them with a cultural tool to make sense of the world in which they live. According to Quiroz (1999), the subjects that the students are taught at school are perceived by students as uninteresting and irrelevant, and generally lead to high “drop out” rates at school.

In the previous sections, characteristics of indigenous knowledge were discussed. It was shown that indigenous knowledge and Western science has similarities as well as differences. Western power, through the power of colonisation, came into the non-Western parts of the world like Africa, and was used to oppress indigenous people (Semali & Kincheloe, 1999). African indigenous knowledge was subjugated by colonisation and replaced by Western science (Semali & Kincheloe, 1999). Indigenous knowledge was seen as primitive, non-scientific, and being without any value (Emeagwali, 2003; Maurial, 1999). The main reason why scientists refuse to recognise indigenous knowledge as science is due to its spiritual base (Snively & Corsiglia, 2001). Brayboy and Castagno (2008) want to use the term science to designate indigenous knowledge because they consider that by that name the devaluation of indigenous knowledge is avoided. The section that follows argues for indigenous knowledge to be considered as science, because Western science is at present considered superior to indigenous knowledge.

2.5.4 Indigenous knowledge as science and its ascent to science

A question that can be asked is: is indigenous knowledge science? If it is, then why call it indigenous knowledge and not indigenous science. The section that follows will attempt to answer this question. Opinions about the authenticity or otherwise of indigenous knowledge vary. On the one extreme there are scholars who regard indigenous knowledge as folklore with little or no scientific content, as well as the fact that it includes beliefs, values, and practices. Snively and Corsiglia (2001) also argue that scientists refuse to acknowledge indigenous knowledge as “science” due to its spiritual basis. At the other extreme are those who assert that indigenous knowledge in every sense of the word is scientific. To resolve this dilemma is to examine critically certain claims within indigenous knowledge in the context of its own paradigms and to seek for common patterns from which meaningful inferences can be made. According to Ogunniyi (2009b), to judge indigenous knowledge from science, there must be criteria set to serve as guidelines such as: that the knowledge is based on careful observation of the phenomenon in question, the procedures for gathering knowledge are replicable, the

knowledge is accessible to others, the knowledge is open to some form of falsification or confirmation experimentally or experientially, the knowledge claims are logically valid or accord with the norms within the referent paradigms, the knowledge has discernable practical implications or provides a valid basis for understanding the phenomenon in question, when a knowledge claim is found to be invalid it should be accepted as such, and that the knowledge is significant enough to warrant scholarly attention, the knowledge is amenable to revision or modification if and when necessary.

What is science? Snively and Corsiglia (2001: 8) mention that the term science originated from the Latin root *scientia*, meaning knowledge in the broadest possible sense, while Ogawa (1995: 588) on the other hand defines science as “a rational perceiving of reality where perceiving means both the action constructing reality and the construct of reality”. He goes on to say that every culture has its own science which he refers to as indigenous science, which is held by a specific cultural group and not by a specific individual. Hardesty (1977), cited by Snively and Corsiglia (2001: 10), describes indigenous science, sometimes referred to as ethno science as “the study of systems of knowledge developed by a given culture to classify the objects, activities, and events of its given universe.”

The argument of Snively and Corsiglia (2001) is that indigenous knowledge should be included within the concept of science, even if it means broadening the concept of science. Their argument is that Western science has made use of diverse indigenous knowledge to grow to the point where it is today. Cobern and Loving (2001: 62) argue that by calling indigenous knowledge science, they would then be submitted to the same criteria as western science, instead of being valued on their own merits, and indigenous knowledge “would have to compete where western modern science is strongest- technical precision, control, creative genius, and explanatory power.” Cobern and Loving (2001: 63) argument is that indigenous knowledge should be established on its own epistemological grounds with its own values, because as they argue, “when there is a gatekeeper and you persuade the gatekeeper to let you in, although you may have influenced the gatekeeper you have also conceded his legitimacy as gatekeeper” (page 63). El Hani and Bandeira (2008) concur with Cobern and Loving (2001) in rejecting

Snively and Corsiglia's (2001) appeal to broaden the concept of science to include indigenous knowledge. According to them, broadening the concept of "science" to encompass other ways of knowing may contribute to the devaluation of indigenous knowledge rather than to their legitimacy. Brayboy and Castagno (2008) want to use the term "science" to designate indigenous knowledge because in this way it is more likely that the devaluation of indigenous knowledge is avoided. Cobern and Loving (2001: 62) argue that

The problem is not that science dominates at what it does best: the production of highly efficacious naturalistic understanding of natural phenomena. The problem is that too often science is used to dominate the public square as if all other discourses were lesser of value.

There are differences between indigenous knowledge and science (Matthews, 1994; Siegel, 1997). Brayboy and Castagno (2008: 13) also mention these differences when they say "Unlike Western science, native science does not attempt to generalise observations to universal laws or to combine observations to make predictions about nature." El Hani and Bandeira (2008: 758) say that "We are just saying that they are different, and should be kept different for the sake of clarity about the nature of knowledge and the nature of science."

2.5.5 The teaching of indigenous knowledge in schools

From the colonial times to the present, Western science is taught in every country as most probably the only valid subject to study natural phenomena. Therefore the practice in science and allied fields are regarded as the accepted practice whilst others are regarded as alternative practice (Ogunniyi, 2009b). School science was imposed on indigenous learners as a culture-free subject. The hegemony of Western science also fails to consider the socio-cultural environments in which students and communities live, and fail to recognise that scientific knowledge is itself socially constructed (Brayboy & Castagno, 2008). According to Brayboy and Castagno (2008), the prescribed objectivity and universalism of western science rationalizes our failure to acknowledge other ways of knowing.

Western science has been considered as the only kind of knowledge and the presumed superiority of Western science has been unchallenged. There are a number of issues that makes it difficult to incorporate indigenous examples into a western scientific framework. Chief among them is the fact that many scientists and science teachers continue to view the contributions of indigenous science as “useful” but outside the realm of “real science” (Snively & Corsiglia, 2001: 21). Siegel (2002: 818) states that “Western science is not the only way to understand the natural world.” Siegel (2002) accepts the need for dialogue viewpoints, but claims that Western science best meets the criteria of good science. Snively and Corsiglia (2001) have proposed teaching “traditional ecological knowledge” along with Western modern science. They view traditional ecological knowledge as providing important resources for understanding the natural world in ways that are less ecologically destructive than Western modern science. Stanley and Brickhouse (1994) have also argued that teaching cultural knowledge is an important way to help students better understands that Western scientific epistemologies are deeply embedded in cultural values. Carter (2004) argued for an approach that acknowledges the ways in which knowledge systems interact with one another and how they change over time. Brickhouse and Kittleson (2006: 196) argues that they do not advocate excluding Western science from the curriculum “since communicating in the language of Western science could be powerful in its own right as well as essential for effective interaction with those in power.” However, in the last two decades or so there has been a greater awareness in many non-western countries of the need to revive the science that is embedded in their indigenous knowledge systems.

Science education could teach students how scientific practices can be linked to a variety of different cultural resources and values (Brickhouse & Kittleson, 2006). According to Aikenhead (2001), educators concerned with the position of science in the education of children in indigenous communities have not abandoned teaching Western science because they found that this kind of science education is well regarded in the communities in which they work. Brickhouse and Kittleson (2006: 196) argue that, although science may continue to be used to strip the earth of its natural resources more efficiently, “it would be wiser to reshape science and science education to serve the

purposes of social justice and eco-justice rather than to abandon science.” Many scholars, for example Aikenhead, Jegede, Ogunniyi, and others have focused their attention on the indigenous knowledge extant in many non-western cultures and the works of these scholars have stimulated interest among researchers in both developed and developing worlds to examine the so-called ethno-science more closely.

To revive the science that is embedded in indigenous knowledge, Aikenhead (1996) states that scholars writing about indigenous science should argue that science education should, first and foremost, encourage students to learn both Aboriginal and Western science and technology in a way that empowers them to make everyday choices between, firstly, participating in a First nations cultural setting and, secondly, participating in a dominant cultural setting. Other researchers have referred to this as “multi science” or “multicultural science education” (Aikenhead, 1996; Brown-Acquaye, 2001; De Montellano, 2001, Irzik, 2001; Irzik & Irzik, 2002; Snively & Corsiglia, 2001).

According to Brayboy and Castagno (2008), the goal of science through a multicultural or culturally responsive lens is not only to connect science to indigenous students’ lives, but also to create better scientist and students with stronger critical thinking skills. Science may present a number of differences and conflicts for some indigenous students because of the assumptions, values, and hegemony science continues to perpetuate. Brayboy and Castagno (2008) argue that the aim of science learning is to facilitate the learning of the culture of science without facilitating the assimilation of students into that culture as well. Snively (1995) also argues that science education should aim to show its own limitation as much as it is currently critical of other ways of knowing. Aikenhead (1996) argues that the curriculum and instruction should be developed which should be embedded in the everyday culture of Aboriginal students. What Aikenhead (1996) argues may look simple in theory, but in practice it is quite difficult to achieve. The main problem lies in the fact that the worldviews underlying mainstream science on the one hand, and indigenous knowledge on the other hand, may be in conflict.

In the previous sections, it was shown that during the apartheid, the scientific worldview dominated other worldviews in schools, and Western science was considered as superior to indigenous knowledge. Therefore indigenous knowledge was not part of what learners learnt at school. When the ANC government took power after the 1994 elections, one of first priorities was to reform education. Some schools changed to a multicultural society in context. In response to the multicultural classroom settings that emerged, the new curriculum, C2005, emphasizes that scientific knowledge and indigenous knowledge must be integrated. The introduction of IKS in C2005, with its principles based on equity in line with the National Constitution has been heralded as an excellent means of promoting a culturally sensitive and relevant curriculum, catering especially for the diversity of all learners in South Africa. However, the policy documents of the Department of Education (2002, 2003) is not clear whether science and IK should be accorded equal status or regarded as competing/complementary worldviews. The section that follows describes the integration of science and IK, as well as the problems associated with the integration.

2.5.6 Integration of Western scientific knowledge and indigenous knowledge

Curriculum 2005 stresses the need to integrate science and indigenous knowledge. Learning outcome 3 of the NCS for Life Sciences states that “the learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in the Life Sciences, and the interrelationship of science, technology, indigenous knowledge, the environment and society” (Department of Education, 2003: 12). Learning Outcome 3 of the RNCS for Natural Science states that “the learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment” (Department of Education, 2002: 10).

Two main reasons given in C2005 for the call to integrating science with IKS are: firstly, that such systems reflect the wisdom and values that people living in Southern Africa have acquired over centuries, and secondly, much of this valuable wisdom is believed to have been lost in the last 300 years of colonisation (Department of Education, 2002).

Furthermore, there is a strong justification for this integration to build self-confidence and unity in the population (knowledge and pride of its technological heritage), as well as for economic interest (especially in the field of medical and pharmaceutical science). Integrating indigenous knowledge into the school curriculum will bring about social change in the society and promote justice and equity (Semali & Kincheloe, 1999).

Lazarus (2011) asks the question: Why should we integrate and what is the motivation for trying to integrate diverse knowledges, including IKS, in our knowledge development process? According to Lazarus (2011), there is value in the different knowledges relevant to a particular area of focus, and bringing these knowledges together would enrich our knowledge. Furthermore, “this merging of perspectives could also be of practical use in the helping of people to engage with the world and address social challenges” (page 24). Lazarus (2004, 2006) researched integration of different knowledges and identified challenges when integrating and which must be addressed. Some of these challenges include: firstly, *language* plays a key role in efforts to integrate different and can act as a barrier to understanding and expression, and must be addressed in appropriate ways, such as constantly defining terms so that everyone can participate in the conversation, secondly, whilst synthesis and integration may be appropriate in many instances, *differences* need to be recognised and valued and failure to recognise such differences may result in important contributions being lost., thirdly, many people deal with *internal conflict* resulting in attempts to embrace two or more worlds and opportunities must be provided to address this conflict, for example valuing different perspectives, and lastly, this *can also occur overtly* when different worldviews engage and need to be facilitated by for example encouraging expression of all perspectives.

The call for the integration of indigenous knowledge into science curriculum has been met with criticism. For example, Onwu and Mosimege (2004: 1) lamented the fact that although the integration of science and indigenous knowledge was premised on good intentions, nevertheless it still failed to address “...the engaging tension perhaps amongst our learners in our schools, between indigenous and scientific ways of knowing with the possibility of each stimulating and supporting the other in our classroom contexts.”

Cobern and Loving (2001) believe that while IKS is a valid knowledge on its own right, it would be better if it were to stand on its own and not be integrated with school science as it will be dominated by the hegemonic powers that school science currently enjoys. Corsiglia and Snively (2001) do not agree with the view of Cobern and Loving (2001) view that IK should not be included in the school curriculum because their view is that “indigenous science offers important science knowledge that Western Modern Science (WMS) has not yet learned to produce” (page 82).

Questions were also asked by researchers regarding the according of IKS equal, but different status, or to view them as competing or complementary thought systems (Onwu & Mosimege, 2004; Rogan, 2004). Le Grange (2000) asserts that indigenous knowledge and science should not be seen as competing perspectives, but should be viewed as complementary frameworks which can exist without the one displacing the other. Other scholars (Emeagwali, 2003; Fleer, 1999; Ogunniyi, 2007a, 2007b) also argued that that the two thought systems should be incorporated together.

The attempt to include IKS within the science curriculum is not unique to South Africa. Similar attempts have also been made in other African countries, Canada, the USA, Australia, the Middle East, and Far East, as well as Central and South American countries (Aikenhead, 1997c; Jegede, 1997; Michie & Linkson, 1999; Snively & Corsiglia, 2001). Ogunniyi (2005) is not convinced that the integration of Western science and indigenous knowledge systems in North America and Australia have been successful. According to him, what these countries have done has been to remove specific aspects of indigenous knowledge from their larger contexts to meet the demands of science.

Teachers also criticized the inclusion of IK into the curriculum. Many teachers argue that there are rarely any explicit examples of IKS in the curriculum compared to the conventional science, and for most of the time very little about IKS is assessed in the final examinations, which in their view, discourages them from attempting to incorporate IKS in their science lessons (Diwu & Ogunniyi, 2011). Another problem which is also

related to assessment is that the Education Department can also be blamed for teachers' discouragement from incorporating IKS in their lesson. When the Curriculum Statements were published in 2002, IK accounted for 20 percent of the question paper. In the new CAPS document, which was implemented in Grade 10 in 2012, IK will only account for ten percent of the question paper. This will definitely discourage teachers even further. The teachers' main opposition to the integration of indigenous knowledge in the integration of IK into the science curriculum can be grouped under three main reasons: firstly, the fact that many teachers in South Africa have been schooled in Western science and hence are more familiar with that worldview than that of IKS; secondly, the new curriculum demands new instructional approaches and goals in terms of contextualization and indigenization; and thirdly, the lack of clarity on how a science-IKS curriculum could be implemented (Jansen & Christie, 1999; Ogunniyi, 1997, 2004).

With regard to the first aspect, namely that the teachers are not familiar with IKS, many contemporary South African teachers, especially the Whites and westernized Coloured and Black teachers are unfamiliar with African Indigenous Knowledge Systems (AIKS) within the conventional science classroom (Ogunniyi & Hewson, 2008). This aspect raises challenges for the teachers. It was mentioned earlier that South African classrooms were becoming more multicultural. What may happen where the worldview of the learners differ from the worldview of the teacher? How can science teachers enable learners to study western scientific ways, and at the same time access the ideas, beliefs, and values of their indigenous knowledge?

With regard to the second aspect, namely the new curriculum demands new instructional approaches, Onwu and Mosimege (2004) state that "what is now needed in the current science education reform agenda is a mechanism for integrating IKS into our school science curriculum in a mutually supportive and inclusive way, so that both forms of knowledge systems can begin to provide the engaging tension among our learners" (page 2). Simon, Erduran, and Osborne (2006) have pointed out that a curriculum that emphasizes alternative goals for classroom pedagogy (such as LO3 in the RNCS and NCS policy documents) is difficult to implement. However, research has shown that a

curriculum that encourages discussion, argumentation, dialogue, and reflection is more effective for promoting understanding of NOS, IKS, or both systems of thought, than one deficient in such instructional strategies (Abd-El-Khalick, 2004; Aikenhead, 1997b; Michie & Linkson, 1999; Ogunniyi, 2004; Simon et al., 2006).

In a similar manner, Snively and Corsiglia (2001) outline a five-step approach for promoting a TEK unit in cross cultural science teaching. This approach provides a general framework for exploring the Western science and indigenous perspective. Snively and Corsiglia (2001) argues that although the two perspectives may interpret the world differently, the students should also see that the two perspectives overlap and can reinforce one another. Furthermore, discussion should stress similarities as well as differences, areas where IK helps to fill the gap where knowledge in Western Modern Science (WMS) is lacking and vice versa (Snively & Corsiglia, 2001)

With regard to the third aspect, namely how a science-IKS curriculum could be implemented, George (1999a) asserts that there exist different categories of IKS, defined by the ease or difficulty with which it could be included in science. George (1999a) has proposed a general scheme for categorizing cultural knowledge for using it in the science classroom. She has suggested four categories:

- a) *Category 1*: the traditional knowledge can be explained in Western science terms. For example, the practice of using a mixture of lime juice and salt to remove rust stains from clothes can be explained can be explained in conventional science terms of acid/oxide reactions
- b) *Category 2*: traditional knowledge can likely be explained by conventional science but is not yet available. For example, a brew made from a plant “vervine” used in the treatment of worms seems to have pharmacological properties, but has not yet been fully tested.

- c) *Category 3*: a conventional science link can be made to traditional knowledge, but the underlying principles are different. For example, traditional knowledge states that sugars cause diabetes, whereas conventional science claims that when one is diabetic, the ingestion of sugars can worsen the condition.
- d) *Category 4*: the traditional knowledge cannot be explained in conventional science terms. For example, there is no conventional science explanation for the claim that if one cuts one's hair when the moon is full, the hair will grow to an increased length.

Categories 1 and 3 lend themselves to easier implementation in the classroom than categories 2 and 4 (George, 1999a).

For the past two decades researchers worldwide have sought for ways and means to implement culturally sensitive curricula that address the learners' indigenous knowledge systems (Aikenhead, 1996; Aikenhead, 2001; Jegede & Aikenhead, 1999; Jegede & Okebukola, 1991; Kawagley, Norris-Tull & Norris-Tull, 1998; Ogunniyi, 1988; Ogunniyi, Jegede, Ogawa, Yandila & Oladela, 1995; Onwu & Mosimege, 2004). The underlying assumptions of these studies are that before teachers can help their learners to integrate science and indigenous knowledge systems, they too must have an adequate understanding of the two thought systems. The teachers' knowledge and understanding of science are said to influence the way they teach science in the classroom.

Various seminars, symposia, and workshops have been organised to assist teachers in their integration of science and indigenous knowledge (Bak, 1999; Ogunniyi, 1997; Onwu & Mosimege, 2004). For the past ten years there have been an increase in the awareness of IK, and the teachers' shortcomings in their quest to implement a science-indigenous knowledge curriculum. Researchers sought ways and means to assist the teachers to implement a science-indigenous curriculum (Ogunniyi, 2007a, 2007b; Ogunniyi & Hewson, 2008; Onwu & Ogunniyi, 2006; Webb, Ogunniyi, Sadeck, Rochford, Dlamini & Mosimege, 2006).

Indigenous knowledge is not documented and is not readily available to teachers. Textbooks are often the most important contributor to knowledge in science teaching, but at times may also be a source of problems. Many teachers are of the opinion that some textbooks are not helpful to indigenous learners (Diwu & Ogunniyi, 2011). The textbooks that are available in South Africa have attempted to include IKS, but had few cultural activities and mainly had case studies. The textbooks designed for a national market do not accommodate the diversity of environments in the South African context, leaving teachers with very little material to support them (Lubben, 2011). In South Africa we have a diversity of cultures. Each culture will develop their indigenous knowledge because by definition, indigenous knowledge is local knowledge. This diversity of cultures from one community to another will mean that the teaching materials developed for one community will not be transferable to another community. The teaching and learning material must fit into the cultural context of the local community.

Ninnes (2000) analysed two textbooks, one used in Australia and the other in Canada, with a specific focus on the incorporation of indigenous knowledge into the texts.

Ninnes (2000) describes a number of problems with the approaches to the inclusion of indigenous knowledge taken by the textbooks. The first problem relates to “creating a representation of indigenous peoples which is homogenous” (page 612). The argument is that in this manner stereotypes are being promoted. This problem can be avoided by referring to the knowledge of specific indigenous groups. The second problem relates to representations of indigenous people as “traditional” which tends to prescribe notions of authenticity to particular indigenous identities and this kind of prescription presents a form of cultural imperialism. A third problem concerning representations of indigenous knowledge relates to the tense used when describing indigenous knowledge. The use of the past tense to describe extant beliefs and practices may give the impression that these beliefs and practices have been superseded by ‘modern’ scientific views. The final problem arises from the representation that only certain people have the right to know particular pieces of knowledge. Whether permission has been obtained or the need to obtain such permission by the authors is for the most part unknown.

The introduction of indigenous knowledge into the formal science curriculum warrants the use of innovative instructional approaches. Ogunniyi and Ogawa (2008) highlight instructional strategies, which include the use of a holistic or integrated approaches; adhering to the constructivist wisdom by starting the lesson with the learners' prior knowledge before introducing them to new ideas; extending classroom discussion to include the IKS modes of inquiry; and learners must be involved in problem-solving activities and to argue, dialogue, discuss, and express themselves freely without feeling intimidated.

In section 2.3 it was shown that in a constructivist approach, a lesson starts with the learners' prior knowledge before introducing them to the new ideas. Local knowledge is the knowledge a learner acquires in his/her community and society. The section that follows will explain how this local knowledge may influence the learning process of the learner.

2.5.7 Local knowledge (indigenous) as prior knowledge

Students bring to the classroom ideas based on prior experience and children of different cultural backgrounds frequently interpret science concepts differently than the standard scientific view and teachers need to begin instruction by determining the prior knowledge of the learners (Jegade & Okebukola, 1991; Ogawa, 1995; Snively & Corsiglia, 2001). Teachers need to probe for and incorporate the prior beliefs of indigenous children (Snively & Corsiglia, 2001). Cobern (1996a: 589) asserts that science education as it is conceptualised frequently has little or no meaning for many students because "it fails to teach scientific understanding within the actual world in which people live their lives". Researchers have pointed out that the prior knowledge of indigenous learners may actually conflict with Western science (Baker & Taylor, 1995; Cobern, 1996a). Cobern (1996a), for example, asserts that construction of knowledge involves interpretation influenced by prior knowledge. Therefore we should not expect for example Nigerian students to understand science exactly the way students in western countries understand

science. The Nigerian student will construct a view of science based on a Nigerian understanding of the human beings and the essence of the natural world, which does not mean to say it is unscientific (Cobern, 1996a: 304)

The term ‘local knowledge’, ‘traditional knowledge’, indigenous knowledge, ‘ethno science’, ‘informal knowledge’, and folk knowledge are used as synonyms, although each one has its own drawbacks (Nygren, 1999). According to Antweiler (1996), local knowledge may on the one hand comprise fixed and structured knowledge which can be articulated, or on the other hand may by virtue of its combination with the performance of actions involve a more fluid process of knowing. Local knowledge forms a relatively organised body of thought based on immediacy of thought Nygren (1999). Traditionally, scientists simply did not see local forms of knowledge as having anything important to say. This has resulted in a view of local knowledge as non-knowledge (Nygren, 1999). Scientific knowledge was defined as the paradigm of knowledge. However, there are an increasing number of environmentalists and alternative movement activists who assert “that it is time to replace the reductionist framework of science with a methodology that draws its guidelines from non-western traditions, based on holistic ways of knowing” (Nygren, 1999: 274).

According to Ogunniyi (2008), commonsense knowledge is acquired largely non-formally, incidental and virtually every member of a given community overtly or covertly contributes something to the repertoire of our commonsensical knowledge. Driver, Asoko, Leach, Mortimer, and Scott (1994) assert that during the years of childhood, children’s ideas evolve as a result of experience and socialization into “commonsense” views. The commonsense ways of explaining phenomena represent knowledge of the world portrayed within everyday culture. Local knowledge has been traditionally viewed as non-knowledge by scientists, and that local form of knowledge not having anything important to say. Scientific knowledge on the other hand has been defined as a paradigm of knowledge, and the only epistemologically adequate one (Nygren, 1999). Generally the most familiar fields of local knowledge which can be analytically distinguished are factual knowledge relating to specific themes, for example environmental knowledge,

agricultural knowledge and medical knowledge. Today the hegemony of science is criticized by alternative movement activists who emphasize the necessity of creating space for competing modes of knowledge (Nygren, 1999).

The question that can be asked is: is local knowledge equivalent to the knowledge gained through western science, or is it structured entirely differently? Local and scientific knowledge display commonalities and differences. For example, both scientific and local knowledge are based fundamentally on observations of the outside world. One difference between science and local knowledge is that science seeks information which is not context-bound whilst local knowledge seeks knowledge which is context-bound (Antweiler, 1996). Also, in contrast to science, local knowledge occurs in some cases in the form of magic (Antweiler, 1996). Local knowledge also has its weaknesses. For example, the validity of local knowledge is locally restricted, for example, they cannot be transferred to other local contexts. The potential for generalization is also limited.

Antweiler (1996) argues about the radical polarization of local or “indigenous” knowledge on the one hand and “scientific” knowledge on the other hand. They are therefore seen as mutually exclusive, and separated by a “great divide” in spite of the fact that they have many things in common and could be mutually enriching. Ogunniyi (2008) concurs with Antweiler (1996) and points out that both are complementary rather than polar opposites.

2.5.8 Indigenous knowledge and environmental education

The debate on the value and role of indigenous knowledge systems and practices in biodiversity conservation has been going on for a long time. In 1992, many countries around the world adopted a blueprint for sustainable development referred to as Agenda 21 (United Nations Conference on Environment and Development [UNCED], 1992), which covers issues associated with indigenous knowledge. International conversation and education bodies (e.g., Worldwide Fund for Nature [WWF]; International Union for the Conservation of Nature [IUCN]) also upheld and supported advocacy for need to

respect and consider indigenous peoples and their diverse knowledge systems in both conservation and environmental education processes (Reid, Teamey & Dillon, 2004).

The need to value local knowledge in environmental education processes can be tracked back to the 1977 Tbilisi Conference which formulated the twelve principles for Environmental Education (UNESCO, 1978). The Tbilisi principles of environmental education have embedded in them, perspectives that called for the recognition of learners' diverse socio-cultural backgrounds and historical contexts. The Tbilisi principles were globally binding in nature and received recognition and respect from environmental education practitioners (UNESCO, 1978). South Africa selectively embraced Tbilisi principles and omitted the more critical principles that would have raised awkward questions about apartheid policies (Le Grange, 2010).

The principles for Environmental Education for Equitable and Sustainable Societies, adopted by the International NGO forum at the Earth Summit in Rio de Janeiro in 1992, were a mobilising influence in developing work on indigenous knowledge processes among South African environmental educators (O'Donoghue & Neluvhalani, 2002). Principles 7 and 9 were very influential in shaping and promoting research in indigenous knowledge and environmental education. Principle 7 maintains that "Environmental education must recover, recognise, respect, reflect and utilise indigenous history and local cultures, as well as promote cultural, linguistic and ecological diversity" (O'Donoghue & Neluvhalani, 2002: 123). Principle 9 advocates that "Environmental education values all different forms of knowledge. Knowledge is diverse, cumulative and socially produced and should not be patented or monopolised (O'Donoghue & Neluvhalani, 2002: 123).

Work done by a number of researchers such as Dei (2002), Gough (2002) and Le Grange (2004) resulted in an increased interest in indigenous knowledge systems with environmental education and had a huge influence in giving momentum to research in IKS. These researchers contributed significantly to the current understanding of the discourse and history around the revaluation of IKS. In Southern Africa, researchers such as O'Donoghue and Van Rensburg (1999), Neluvhalani (2004) and Shava (2000, 2005)

have contributed to the current understanding of IKS and how these can be integrated in environmental education processes. In the field of environmental education in southern Africa research projects are increasingly exploring a variety of possibilities which have begun the delicate and complex work of uncovering and recovering what has been marginalised and loss of decades of domination (i.e., O'Donoghue & Neluvhalani, 2002; Shava, 2000). O'Donoghue (1994: 4) expressed the view that "Indigenous knowledge has historically been transformed to become both a tool of oppression and a voice within the struggle for liberation."

Research findings has shown that contemporary environmental education processes is decontextualised, resulting in learners being exposed to the scientific worldview of the school curriculum and the home everyday worldview which is often ignored by the school system (Mokuku & Mokuku, 2004; Shava, 2000; Shava, 2005). The arena of indigenous knowledge in environmental processes is complex and multi-faceted. In southern Africa efforts have been made to establish "processes of inter-epistemological dialogue, rather than an oppositionalised logic of contrasting indigenous knowledge and Western knowledge as two distinctly different ways of knowing" (Van Damme & Neluvhalani, 2004: 367). O'Donoghue and Neluvhalani (2002: 127) gave examples of how concepts such as water collection; storage of grain; and fermentation of *amasi* (sour milk) could be discussed with learners in an inter-epistemologically orientated manner, where the indigenous wisdom communicates and complement the western scientific knowledge propositions. Furthermore, attention is being paid to the processes of mobilising indigenous knowledge in context in ways that recognise the tacit, contextual nature of indigenous ways of knowing, and which recognise and consider the significance of mother-tongue instruction in a context where mother-tongue has been marginalised (O'Donoghue & Neluvhalani, 2002). O'Donoghue and Neluvhalani (2002: 123) asserts that while the last few years have seen an explosion of interest in indigenous knowledge among environmental educators within southern Africa, "not much that is tangible has materialized, and as yet, little has been translated into curriculum perspectives and learning support material."

2.6 Chapter summary

In this chapter, the literature of the conceptual basis for the current study is reviewed. The literature on curriculum reform in South Africa, constructivism, and multiculturalism is reviewed. However, only a brief description is given with regard to these aspects. A detailed analysis of curriculum implementation and indigenous knowledge is given.

In the first part of the chapter a brief introduction of the state in curriculum reform in South Africa is given. The chapter starts with a brief outline of reasons why a new curriculum was implemented in South Africa. One of the priorities of the new ANC led government that took power in South Africa after the 1994 elections was to reform the educational system (Rogan & Grayson, 2003). One of the undertakings was to develop a new curriculum. Whilst the policy documents of the Department of Education contained many visionary and educationally sound ideas, the implementation of the new curriculum was problematic (Rogan & Grayson, 2003). Problems of the implementation of the new curriculum are discussed.

Secondly, a brief explanation of constructivism is provided. According to constructivism, learners construct their own knowledge. However, the learners do not come to the classroom with *tabula rasa* minds. The learners have prior knowledge, affected by socio-cultural factors, which may or may not agree with school science. Children of different cultural backgrounds frequently interpret science concepts differently than the standard scientific view (Snively & Corsiglia, 2001). Teachers therefore need to begin instruction by determining the prior knowledge of the learners because the learners bring a broad range of ideas, beliefs, values and experiences to the classroom. The role of the teacher as a facilitator is highlighted, as well as the influence of the learners' prior knowledge on their learning.

Thirdly, the review of the literature shows that classrooms in South Africa are becoming increasingly multicultural. As a result of desegregation schools in South Africa changed to a multicultural society context. The teaching and learning process are influenced by the

cultural values of both the teacher and the learner. In classrooms where the worldview of the learners differ, and which may also differ to the worldview of the teacher, clashes may occur. A cross-cultural approach to teaching of science is suggested because of the cultural differences between the learners and school science (Jegede, 1995).

Lastly, policy documents of the Department of Education state that indigenous knowledge and scientific knowledge must be integrated. Indigenous knowledge is defined, and the similarities and differences between IK and Western science are highlighted. Before democracy, Western science dominated IK, which was considered inferior and unscientific. After democracy, curriculum reform took place. IK was to be integrated with scientific knowledge. The reason why integration must take place is explained, as well as the problems associated with the integration are highlighted. Instructional strategies, to implement a science-indigenous knowledge curriculum, such as the five-step model of Snively and Corsiglia (2001), are provided.

In the next chapter, the research methodology used in this thesis is explained and described.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The aim of this study is to describe whether the integration of scientific knowledge and indigenous knowledge, as required by the South African Department of Education, is being implemented by high school Life Sciences and Natural Science teachers in different school settings in the Western Cape Province of South Africa. This study also aims to establish the problems teachers encounter in their classroom implementation of the integration of science and indigenous knowledge, and to provide an intervention that assists them with the required integration.

This chapter provides a detailed explanation of the research methods used in this study as well as the rationale for the research approach adopted to answer the research question listed in Chapter 1 (page). Furthermore, the chapter outlines the research design used in structuring the methodology. This section explains the combination of research methodologies used in this study, by explaining what each method entails, and describing the advantages as well as the disadvantages of each method. The research methodology is described in eight distinct stages. In the first five stages, the collection of the quantitative data is discussed with regard to development of the survey instrument, its pilot study, the administration of the survey in schools, the capturing and cleaning of the quantitative data, and the analysis of the quantitative data. In the sixth stage the quasi-experiment is described. In the final stages, the qualitative data are discussed with regard to its collection, ending with the techniques used in the analysis of the qualitative data.

3.2 Research design

The researcher used a research design involving multiple research methods (e.g., Hammond, 2003; Morse 2003) that were combined to help to examine science teachers' implementation of indigenous knowledge in the science curriculum. In determining which research design to utilise, the researcher used the typology of research purposes identified

by Newman, Ridenour, Newman and DeMarco Jr. (2003). According to Newman et al. (2003), there is a link between understanding the purpose of one's research and selecting appropriate methods to investigate the research questions that are derived from the purpose. The typology of research purposes of Newman et al. (2003) lists nine broad categories for social sciences: predict; add to knowledge base; have a personal, social, institutional, and/or organisational impact; measure change; understand complex phenomena; test new ideas; generate new ideas; inform constituencies; and examine the past. Conceptualising the typology as categories, and given the research questions outlined in Chapter one (page 8), category four, namely 'measuring change' is the purpose of this research study.

From this broad category, more specific purposes are delineated by Newman et al. (2003). For the category 'to measure change', three specific outcomes are identified, namely, to measure consequences of practice; to measure treatment effects; and to measure outcomes (Newman et al., 2003). Two purposes drive this research, namely, to determine whether the integration of indigenous knowledge in the science curriculum is being implemented by science teachers and to assist the teachers through an intervention in integrating indigenous knowledge in the science curriculum using Snively and Corsiglia (2001) as a framework. To fulfill the first purpose, a quantitative study using a survey instrument was used. Subsequently, classroom observations were made to describe the effect of the intervention on the teachers' teaching. Thus, a quasi-experimental study was designed to collect qualitative data before and after the implementation of the instructional treatment. Teachers as well as learners were interviewed. Furthermore, in this study coded qualitative data were transformed into quantitative data. Therefore, in this research study, the methods were not restricted to quantitative or qualitative research methods but consisted of different research methods which were combined, and included, for example, quantitative survey research and quantitative quasi-experimental research with qualitative in-depth interviews and qualitative participant observations.

From the above, it can be concluded that the study made use of multiple research methods to conduct the research to provide credible and trustworthy answers to the research questions posed in Chapter 1.

3.2.1 The multi-method research design

Multi-method research is when different approaches or methods are used in parallel or sequence but are not integrated until inferences are being made (Johnson, Onwuegbuzie & Turner, 2007). The mixed-methods approach to research refers to the practice whereby the researcher combines quantitative and qualitative methods in one study (Johnson & Onwuegbuzie, 2004). When using a multi-method design, data are not usually combined within projects and each study is planned and conducted to answer a particular sub-question (Morse, 2003). Rather, in a multi-method design each study is planned and conducted to answer a particular sub-question. Methodological integrity must be respected in a multi-method design and each method must be kept intact and the assumptions, sampling (appropriateness, adequacy of data) should not be violated (Morse, 2003). An awareness of working inductively or deductively at any given time will ensure that the assumptions of each method are not violated.

Using a multi-method approach is to draw from the strengths and to minimize the weaknesses of both qualitative and quantitative methods in a single research study or set of related (Johnson & Onwuegbuzie, 2004). The use of multi-method design ensures greater credibility in the findings of the study, and provides one with a different perspective of the phenomenon as well as a more comprehensive picture than using either qualitative or quantitative methods alone (Hammond, 2005; Morse, 2003). Thus, there is wide consensus that using different types of methods in a single study can strengthen a study (Cresswell, Plano- Clark, Gutmann & Hanson, 2003; Tashakorrie & Teddlie, 2003).

When using a multi-method research design, data are not usually combined within projects, as may occur in a mixed-method design (Morse, 2003). The strength of using multi-method design is to obtain different levels of data. The two studies in a multi-

method design are independent and together provide a more comprehensive picture than either would alone (Morse, 2003). Using multi-methods can offset the disadvantages that either quantitative or qualitative methods have by themselves. Greene, Caracelli and Graham (1989) outlined the following five broad purposes of multi-method studies: a) triangulation (i.e., seeking convergence and corroboration of results from different methods studying the same phenomenon); b) complementarity (i.e., seeking elaboration, enhancement, illustration, clarification of the results from one method with results from the other method); c) development (i.e., using the results from one method to help inform the other method); d) initiation (i.e., discovering paradoxes and contradictions that lead to re-framing of the research question); and e) expansion (i.e., seeking to expand the breadth and range of inquiry by using different methods for different inquiry components). Triangulation can help to overcome the weaknesses and/or inherent biases and problems that may result from the use of a single method. Complementarity, on the other hand, can lead to multiple inferences, confirming or complementing each other. The other three functions, namely, development, initiation, and expansion are more related to mixed-method studies in which inferences are made at the end of one phase, leading to questions and/or design of the second phase. Thus, by offsetting the disadvantages that the methods have by themselves, the validity of enquiry findings is enhanced.

The multi-method approach to research also has its weaknesses. First, it can be difficult for a single researcher to carry out both qualitative and quantitative research, because some methodological purists contend that one should always work within either a qualitative or quantitative paradigm (Johnson & Onwuegbuzie, 2004). Second, it may be very time-consuming and more expensive to collect both qualitative and quantitative data.

The multi-method approach therefore requires careful planning. The sequential explanatory mixed-method strategy (Morse, 2003), which sets out the order of the data collection procedure, was used as a strategy to overcome the disadvantages of the mixed-method approach, and this strategy will be described in the next section.

3.2.2 The sequential multi-method strategy

The sequential strategy enables the researcher to plan the research process by setting the order of the data collection. Sequential explanatory multi-method data collection strategies involve collecting data in an iterative process where the data collected in one phase contribute to the data collected in the next phase (Driscoll, Appiah-Yeboah, Salib & Rupert, 2007; Morse, 2003; Tashakorrie & Teddlie, 2003). In the sequential multi-method research design, the method that theoretically drives the research is conducted first, with the second method designed to resolve problems/issues uncovered by the first phase or to provide a logical extension from the findings from the first phase. In the present study, the purpose of the research is to determine the teachers' understanding of indigenous knowledge and the problems the teachers encounter in their classroom implementation of the integration of indigenous knowledge in the science curriculum. Here, priority is thus given to the quantitative data, and in the first phase data are collected through a newly adapted and developed questionnaire. The second phase which followed involved a quantitative quasi-experiment, as well as qualitative data that were collected and analysed second in the sequence to help explain, or elaborate on, the quantitative results obtained in the first phase.

3.2.3 Application of the sequential mixed-method strategy

The sequence for the data collection and analysis for the present study is given in Figure 3.1, and shows how the first phase, the quantitative data collection phase, was combined sequentially with the small-scale second phase, the qualitative data collection phase. The aim of the first phase was to establish the teachers' understanding of indigenous knowledge, and the problems they encountered in their integration of science and indigenous knowledge in the classroom. The first phase formed the major part of the research and was referenced QUAN (for quantitative) in line with conventions used by Morse (2003). The first phase involved the collection of quantitative data through a newly adapted and developed questionnaire, the *Nature of Indigenous Knowledge Questionnaire* (NOIKQ). The QUAN data collection involved five stages: first, administering the

NOIKQ to 50 teachers in eight schools during the pilot study, and, second, administering the final data-gathering instrument to 370 teachers in eighty schools. In stages three to five the QUAN data were subsequently analysed and the findings were used for further data collection during the second phase. For the second phase eleven teachers, who previously completed the survey questionnaire, were purposefully selected. Resource material was developed for learners as well as teachers and the teachers were trained in methods how to integrate indigenous knowledge in their lessons. To establish the effectiveness of the intervention, a quasi-experiment was designed. The teachers were observed in their classrooms teaching a science lesson with an indigenous component, as well as learner and teacher interviews during the second phase, the qual (for qualitative) phase in line with conventions used by Morse (2003). The data of the qualitative and quantitative phases was subsequently combined to produce narrative stories, which comprised the interpretation phase of the study.

Sequentially separating the quantitative and qualitative data collection ensured that steps could be taken within each of the studies to maximize the validity of the results. First, the data collection instruments (i.e., questionnaire and resource materials) were validated by Life Sciences Curriculum advisors as well as experienced Life Sciences and Natural Science teachers. These individuals were chosen for their expertise and ensured that the data collection instruments had content validity.

Second, the researcher established rigour in the study to ensure that the findings were valid. The researcher sought to do this by Guba and Lincoln's (1989) criteria of *prolonged engagement* (i.e., the amount of time spent establishing rapport and to build trust with the participants in order to understand the context more fully); *persistent observation* (i.e., the duration and number of observations, which should be sufficient to enable the researcher to identify crucial characteristics of the case); and *member checks* (i.e., the sharing of documented data and interpretations with the participants to ensure that a realistic picture is presented). Thus, the rigour practiced maximized the validity of the results.

Third, trust was an important issue to consider during the qualitative data collection phase. According to Lincoln and Guba (1985), participants are likely to be both candid and forthcoming if they respected the inquirer and believed in his or her integrity. The researcher is a senior Life Sciences teacher and senior marker and sub-examiner in the Senior Certificate examinations, and is therefore credible, respected by, and well known to many principals and Life Sciences teachers throughout the Western Cape Province. The topic of the research, namely the classroom integration of scientific and indigenous knowledge, was one aspect that most teachers were unfamiliar with. The researcher presented aspects of the research at seminars and workshops and was therefore knowledgeable about the topic of the research. Teachers from various schools attended these workshops and expressed their frustration with their lack of understanding and knowledge of indigenous knowledge. The teachers were aware that the researcher came from a teaching background. Thus, the teachers felt supported and therefore felt confident to communicate many aspects about their teaching. As mentioned in the section on the administration of the questionnaire (page 72), the researcher was allocated an hour for the teachers to complete the questionnaires. Many teachers could have easily completed the questionnaire quickly with the aim to finish their programme that they came to the workshop. However, many teachers requested extra time to complete the questionnaire after the workshop. The teachers trusted the researcher and his research, and this influenced their candid and forthcoming responses during the completion of the questionnaire and interviews.

Before, during, and after the QUAN and qual data collection phase ethical issues were always considered. These are discussed in the section that follows.

3.3 Ethical issues

One of the major issues in qualitative and quantitative research is the importance of ethical considerations in establishing collaborative relationship of trust with the participants, as well as gaining access to the schools of the participants. The participants in this research were learners, teachers, and curriculum advisors who agreed to complete questionnaires and/or to be video-taped during classroom observations and/or to be interviewed.

Classroom observations can be intrusive for those who are being observed, can find the experience stressful, and are therefore not keen to participate (Muisj, 2004; Opie, 2004).

At any stage during the research study, it might have been possible that sensitive information were revealed. Therefore, out of concern for the school, teachers and learners, the following safeguards were employed. The researcher wrote a letter to the Director of Research at the Western Cape Education Department, requesting permission to conduct the research at schools in the Western Cape (Appendix 1, page 205). Permission was granted (Appendix 2, page 206). The researcher presented a letter to schools requesting participation in the survey (Appendix 3, page 207).

The researcher had to obtain informed consent from the participants of the research. Cohen, Manion and Morrison (2007: 52) defined informed consent as “the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions.”

According to Cohen et al. (2007), informed consent encompasses four elements, namely:

- a. *Competence* where participants will make the correct decision if given the relevant information;
- b. *Voluntarism* where participants will choose freely to participate (or not);
- c. *Full information* implies that consent is fully informed; and
- d. *Comprehension* which implies that participants fully understand the nature of the research project.

All teachers who participated in the quantitative phase of the research (i.e., completed the survey questionnaires) were duly informed as to the exact purpose and nature of the research study. The teachers were informed that their participation in the research study was voluntary, which gave them the option to withdraw from completing the questionnaire. The participants were promised confidentiality and anonymity. Participants were requested not to write their names or the names of their schools on the questionnaires. Thus, the participants have remained anonymous, and for this reason

pseudonyms have been used throughout this thesis to protect their identities, as well as that of their schools.

The teachers who participated in the qualitative phase of the research were informed that they would be trained in the integration science and indigenous knowledge through a workshop, followed by classroom observations where they would be video-taped, as well as being interviewed. These teachers completed a confidentiality agreement (Appendix 4, page 208).

The information gathered in this study, namely, the survey questionnaire, interviews, and video-recordings, is appropriately stored as a measure to guarantee protection of the confidentiality agreement entered into with the teachers.

3.4 Research methods

In this section, a detailed description of all the stages and steps the researcher followed to develop the instrument, collect the data, and analyse the data is provided. In section 3.2 it was shown that the researcher used a research design involving multiple research methods, where the phenomenon of the implementation of IK in the science curriculum is studied independently using two or more different research methods. Phase 1 of this study involved an exploratory study gathering quantitative data. The description of this phase comprises five stages, starting with the development of the instrument to be used for the collection of the quantitative data. The second stage involved describing the pilot study where the instrument was piloted with a number of teachers. The third stage involved the administration of the instrument to 370 teachers from 80 schools. The fourth stage involved capturing and cleaning the data collected during the quantitative data collection phase. The fifth stage involved analyzing the quantitative data. The preliminary findings of the quantitative data were used for phase two of the study. In the sixth stage details of the quasi-experimental design are discussed. In the seventh stage qualitative data was collected. Finally, the approaches used for analysis of the qualitative data are described in order to provide credible and trustworthy answers to the research questions.

3.4.1 The first quantitative phase

The first phase of this research involved the collection of quantitative data. During the quantitative data collection phase, a newly adapted and developed survey instrument was used to capture the teachers' understanding of indigenous knowledge, as well as to determine the problems teachers say they encounter in the integration of science and indigenous knowledge in the classroom. The purpose of this survey was to obtain a detailed description of high schools science teachers' understanding of scientific and indigenous knowledge, as well as the problems the teachers encounter in their implementation of Learning Outcome 3 of Life Sciences and Natural Science. A survey is an efficient and cost effective way of obtaining information from a large number of individuals (Cohen et al., 2007), and can ensure confidentiality and anonymity (Kumar, 1996; McMillan & Schumacher, 1993) and non-traceability of respondents (Cohen et al., 2007).

Stage 1: Development of the new instrument

The survey instrument was developed from the *Nature of Science and Nature of Indigenous Knowledge* (NOSNIK) Questionnaire of Onwu and Ogunniyi (2006) which in turn was derived from the *Traditional Cosmology Test (TCT) & Characteristic of Science* (COS) questionnaire (Ogunniyi et al., 1995). The NOSNIK was purposely chosen because it was developed specifically to assess the teachers' knowledge, understanding, and views of the Nature of Science and indigenous knowledge, as well as the teachers' view on the integration of science and IKS in the classroom. The original NOSNIK draft questionnaire of Onwu and Ogunniyi (2006) was developed by a research team of various Science Education lecturers affiliated to different universities in South Africa. These lecturers were at the forefront of indigenous knowledge research in South Africa, and they were invited to comment on the items in the original NOSNIK and to modify them or add to them should this be necessary, in their opinion.

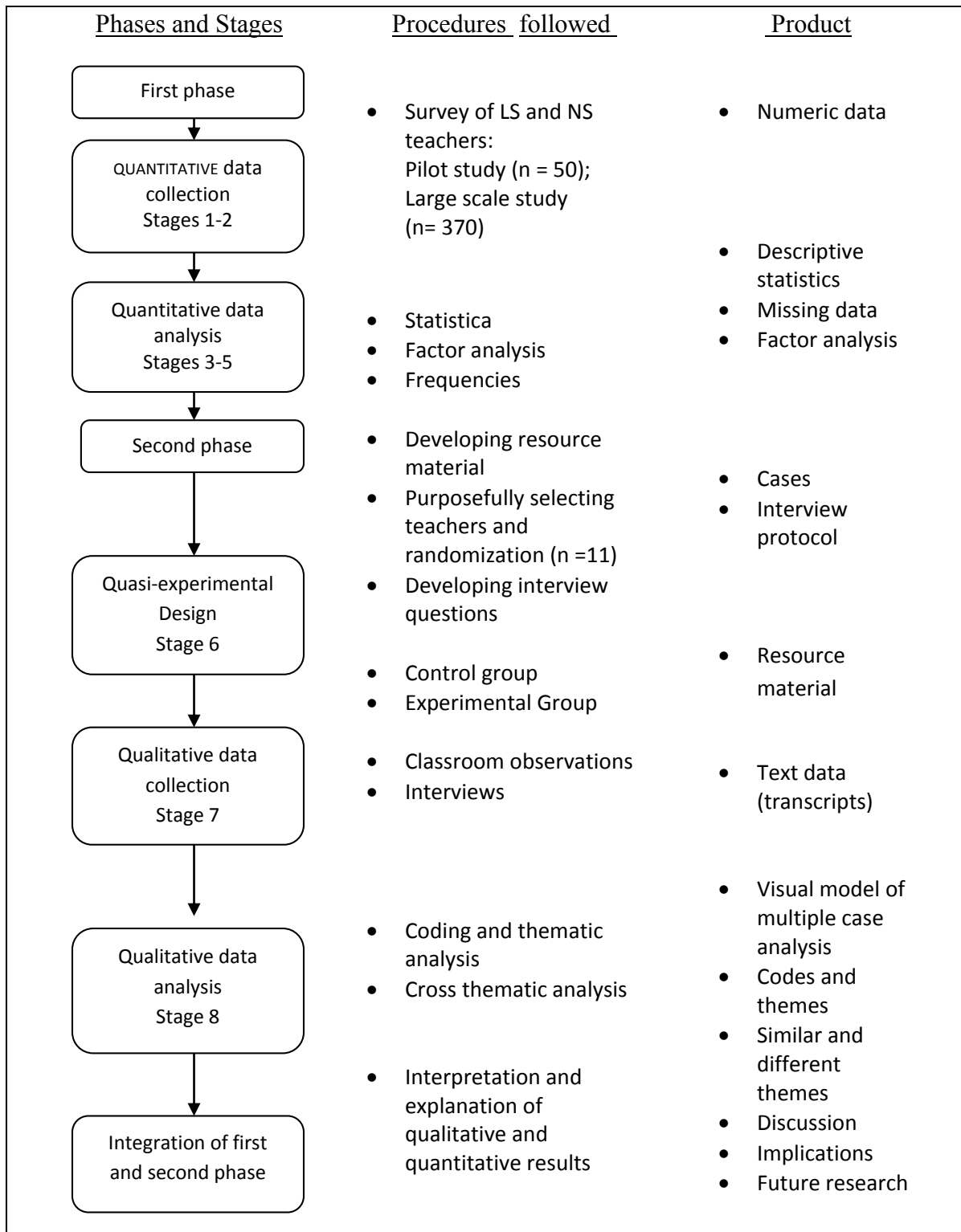


Figure 3.1 Diagrammatic representations of the multi-method data collection and analysis strategy used in this study

The original NOSNIK draft was subjected to a series of revisions as a result of critical comments made by independent Science Education lecturers affiliated to different Universities of South Africa. Furthermore, the NOSNIK was administered to five in-service Life Sciences teachers, to determine the clarity of the NOSNIK questionnaire and the time taken by each teacher to complete the instrument. Based on the comments of the teachers, the NOSNIK questionnaire was further revised by either removing or rewording ambiguous items, or those that appeared to have caused respondents difficulties in understanding and interpretations. The NOSNIK questionnaire consisted of fifty items deemed relevant to the understanding of the nature of the science and indigenous knowledge systems, and items were grouped into five major sections: the C2005 requirements that the curriculum should be sensitive to IKS of the learners; categorization of 21 statements as either science, IKS, or both; ranking of 16 instructional methods most appropriate for integrating IKS with the science curriculum; views about integrating science with IKS; and demographic information of the teachers.

The original NOSNIK questionnaire was administered to 42 prospective and in-service science teachers attached to six South African higher education institutions namely: University of the Western Cape, Nelson Mandela Metropolitan University, University of Cape Town, University of Zululand, University of Limpopo, and University of Pretoria. Two experienced science teachers (one with a Physical Science background and the other one with a Life Sciences background) were asked to rate the items of the original NOSNIK questionnaire on a 1-5 scale in terms of its content and construct validity. In this regard, a poor item was rated 1; a fair item, 2; a good item, 3; a very good item, 4; and an excellent item, 5. Further analysis of the 42 completed questionnaires of the prospective and in-service science teachers produced items which revealed the teachers' knowledge, understanding and views of NOS, IKS and the implementation of the RNCS document. Through the comments/critiques from various stakeholders such as Science Education Lecturers, in-service and prospective teachers, and pilot studies, the final NOSNIK was a shorter, improved version of the original NOSNIK draft questionnaire.

The NOSNIK was adapted and modified by the researcher for use in the present study and was called the *Nature of Indigenous Knowledge Questionnaire* (NOIKQ). The NOSNIK was used to evaluate the teachers' knowledge, understanding and views about NOS and IKS, as well as to elicit the teachers' ideas on how to integrate science and IKS in the classroom. The NOSNIK did not assess aspects related to whether the teachers did receive training on indigenous knowledge, or what problems they encountered in their implementation of Learning Outcome 3 of the RNCS. The NOIKQ was adapted to accommodate these aspects in the following ways. First, in the newly included NOIKQ questionnaire items were on aspects related to whether respondents received any training on indigenous knowledge, whether the textbooks they were currently using were useful, the problems they encountered when they were implementing LO3, as well as what assistance they needed to successfully integrate science and indigenous knowledge. Second, in the original NOSNIK the teachers were given a set of 16 instructional methods originally derived from practitioners in the field, for integrating science and IKS in the classroom. After consultation with Science Education lecturers at the University of Western Cape, whose expertise is indigenous knowledge, the number of instructional strategies was reduced to eleven, because according to these lecturers, some instructional strategies were ambiguous. Third, the section on the C2005 requirements that the curriculum should be sensitive to the indigenous knowledge of the learners was removed and replaced with questions on the NOS, scientific knowledge, and indigenous knowledge. The rationale for the inclusion of these questions in the questionnaire was to establish the teachers' understanding of these concepts.

Many teachers in township² schools, such as Khayelitsha, Nyanga, and Gugulethu are English Second Language speakers (IsiXhosa being the dominant language spoken by those teachers). An English Second Language expert was requested to inspect the language used in the instrument so that it is appropriate for isiXhosa speaking teachers who are English Second Language speakers. This individual was engaged by virtue of her expertise and experience, being a Curriculum Advisor for English First Additional

² The terms African/Black, Coloured and White are used in this thesis. These groupings underpinned the political system of racial classification that characterised apartheid. The African children attended township schools, the Whites ex-model C schools, and Coloureds the Cape Flats schools.

Language at one of the Educational Management District Centres of the Western Cape Education Department. Consequently, particular attention was paid to simplifying the instructions and items without losing their essential meaning. This was done so that the language demands of the items would not be a limiting factor in the teachers' understanding of the questionnaire, thus compromising its reliability. In this regard, a strategy consisted of providing clarifying examples in brackets, for example "After scientist has developed a theory (e.g. atomic theory, cell theory, and membrane theory)." In order to focus the teachers' attention, particularly important instructions for each section were written in bold.

The draft NOIKQ contained four parts. Part A consisted of the teachers' demographic information. Part B asked questions about scientific knowledge and indigenous knowledge, namely, what each one is; what the two knowledge systems have in common and how the two systems differ; how the teacher 'bridges' the two knowledge systems in the classroom; and whether, in the opinion of the teachers, the learners show any understanding of the relationship between their home culture and the science taught in the classroom. Part C contained two sections. In the first section, respondents were given statements/claims regarding scientific knowledge and indigenous knowledge. Respondents were required to indicate whether the statement belonged to scientific knowledge or to indigenous knowledge or to both domains. In the second section, respondents were given 11 instructional methods for integrating scientific knowledge and indigenous knowledge. Respondents were then asked to rank the instructional methods for integrating scientific knowledge and indigenous knowledge from the most important = 1 to the least important =11. Part D comprised of questions requiring the respondents to indicate whether or not they have been exposed to any prior training/workshops on indigenous knowledge, whether or not the currently available school science textbooks were useful in the implementation of Learning Outcome 3, whether or not they included Learning Outcome 3 in their classroom science lessons when teaching, what problems teachers faced when implementing scientific and indigenous knowledge simultaneously, and what workshops/resources teachers needed in order to implement Learning Outcome 3 successfully.

A draft of the researcher's carefully constructed research instrument (NOIKQ) was submitted to a panel of five conveniently selected in-service Life Sciences teachers at one of the Universities in the Western Cape, studying towards their Masters degree in Science Education in 2008, and three Science Education Lecturers at the University of the Western Cape. This panel was chosen for their expertise in Life Sciences, Natural Science, and Physical Science Education. The teachers were all experienced, each of them teaching for more than twenty years, and included Senior Certificate examiners in Life Sciences and Physical Science. Three teachers were responsible for marking Senior Certificate examination scripts in Life Sciences. One of the Lecturers was previously a Life Sciences Curriculum Advisor. The researcher asked the experts to comment on the research instruments in terms of clarity of questions, question construction, scientific accuracy of the items, the time allocated, the readability, specific question wording, response formats, as well as the general layout and wording of the questions.

A meeting was called by the researcher to discuss the responses on the draft NOIKQ by the panel. Problems detected by the panel that is, inconsistencies and ambiguities, were removed. For example in the first section of Part C of the questionnaire, 20 statements were given where the respondents had to indicate whether a statement belonged to scientific knowledge, indigenous knowledge, or both. On 18 of the statements the panel agreed on where the statement belonged. However, in the case of two statements the panel could not come to an agreement. Some felt that the statements belonged to scientific knowledge whilst others felt that the statements belonged to indigenous knowledge. It was then agreed that those items where there was disagreement should not be included in the final version of the questionnaire. Consequently this section of the final questionnaire consisted out of eighteen statements. The final data-gathering instrument reflected the input from people with considerable knowledge in Life Sciences and Natural Science content, and had face, content, and construct validity.

Stage 2: Pilot testing

The draft survey questionnaire was pilot tested on a sample of Science teachers. The major purposes of the pilot study were a) to establish whether the respondents understand the instructions and the answer options in the questionnaire; b) to ascertain whether they found the items unambiguous; and c) to determine how long it will take to complete the questionnaire. The selection of the teachers was based on the type of context in which the school at which they were teaching was located (i.e., whether urban or township) to cover the major types of schools representing the vast majority of teachers in the Western Cape Province. The questionnaire was given to 50 conveniently selected teachers at eight high schools from urban and township schools. Only teachers who taught Life Sciences or Natural Science were selected to complete the draft questionnaire.

Before commencing with the pilot test, the researcher explained the purpose of the NOIKQ questionnaire, as well as the instructions, to the respondents. The pilot-test teachers were asked to read through the instructions and items, and to underline sentences and words they did not understand or felt to be ambiguous. Thereafter researcher collected the completed questionnaires, and then randomly selected eight teachers to be interviewed. These teachers were asked their opinions about the response format and instructions of the questionnaire. After an analysis of the completed questionnaires, the researcher concluded that the items, instructions, and response formats were well understood by the participants. However, in Question C2, where the instructional methods for integrating science and indigenous knowledge were to be ranked from the most important = 1 to the least important = 11, the respondents only wrote either a 1 or an 11 as their ranking. This misunderstanding was taken into account and the questionnaire was modified. In Question C2 for example, examples of how the items were to be ranked were given to avoid the confusion of the question format. The revised questionnaire underwent a further pilot study at one school involving a further ten science teachers. There were no modifications which had to be made to the questionnaire, and the final questionnaire was ready to be administered to the main study. The final NOIKQ is given in Appendix 5 (page 209).

Stage 3: Administration of the NOIKQ

Convenience sampling and purposeful sampling, as outlined by Onwuegbuzie and Leech (2007) characterised the samples of respondents and schools. This sampling strategy ensured a total sample of 370 high school science teachers in 80 public schools, represented by urban and township schools in the Western Cape Province.

The Western Cape Education Department (WCED) manages all the public schools in the Western Cape Province in groups called Education Management and Development Centres (EMDCs). There are seven EMDCs in this province namely: Metropole East (ME), Metropole North (MN), Metropole North (MN), Metropole Central (MC), Overberg, South Cape/Karoo, and West Coast/Winlands. Four EMDCs, namely MN, MS, ME, and MC comprises approximately 50% of all urban and public schools, whilst the other three EMDCs consist of rural schools. The schools in this sample were selected from four EMDCs, namely MN, MS, ME, and MC, which consist of urban and public schools (Department of Education, 2003). Prior to the administration of the survey to the sample schools, permission to involve teachers at these schools was sought from the Director of Research at the Department of Education in the Western Cape. After the written permission was granted, the questionnaires were ready to be administered in all the selected secondary schools.

The administration of the NOIKQ occurred in two distinct phases. The first phase involved Grade 12 teachers who attended a particular workshop during February and March 2007 where planning and orientation for the new academic year is done by the Curriculum Advisor. During December 2006 the researcher approached Life Sciences Curriculum Advisors at the Education Management District Centres (EMDC), namely ME, MN, MS, and MC, requesting them to administer the NOIKQ questionnaire in 2007 during the planning and orientation workshops held during February and March in 2007 which would be conducted by them. All the Life Sciences Curriculum Advisors agreed. However, during 2007 the Curriculum Advisors informed the researcher that they would not administer the questionnaire, but that an hour would be allocated to the researcher at

the planning and orientation workshops for him to administer the questionnaire himself. During February and March 2007, the researcher attended the workshops of the Grade 10-12 Life Sciences teachers. The duration of these workshops is normally three hours. The Curriculum Advisor introduced the researcher to the teachers and the teachers received an explanation of the aims, purposes, and intent of the research by the researcher. The teachers were assured that their responses would be dealt with confidentially and anonymously. The teachers were also informed that the research had the approval of the WCED, but that their participation in the research was voluntarily. Fortunately all the teachers who were invited to participate responded positively to the request, and took an average of 30-45 minutes to complete the questionnaire. The researcher collected the completed questionnaires. The importance of this research is highlighted by the interest shown by the Curriculum Advisors and teachers when the Curriculum Advisor at Metropole Central requested the researcher to conduct a workshop on indigenous knowledge during the planning and orientation workshop of Grade 10-12 teachers. The researcher informed the Curriculum Advisor that the data were to be collected first, followed by the workshop so that the data collection process was not contaminated. Data were collected from the teachers at that particular EMDC for one week during March 2007. The teachers were again given an explanation of the purposes and aim of the research and were told that completing the questionnaire was voluntarily and confidential. All the teachers completed the questionnaire on an average of between 40-45 minutes.

The second phase involved science teachers at the various schools who did not attend the planning and orientation workshops for Grade 12 teachers held by the Life Sciences Curriculum Advisors during February and March 2007. The researcher approached the principals of high schools in the four EMDCs mentioned previously, and enquired whether the science teachers for Grade 8-11 could participate in the research. Interestingly, having permission from the WCED did not always guarantee access to schools. A letter of introduction from the researcher (Appendix 6, page 217), explaining the nature of the survey, was presented to the Principal. In this letter the teachers were also informed that their participation in the research was voluntarily and that their responses would be dealt with confidentially and anonymously. The Heads of the Science departments were asked

to act as co-ordinators to distribute the questionnaires and return them to the researcher. The researcher is aware that teachers do not have time to fill in questionnaires, and will sometimes only accept a questionnaire but will not make an effort to complete it. To circumvent the possibility of a poor response which may reduce validity and reliability of the research, individual teachers were approached by the researcher to illicit support and interest. The data was collected between March and June 2007. The researcher collected the completed questionnaires at the various schools.

Stage 4: Capturing and cleaning of the quantitative data

Data, as described above, was gathered from 370 teachers at 80 schools within four EMDCs in the Western Cape Province. Any questionnaires considered invalid were withdrawn from the sample. A questionnaire was considered invalid if there were instances where there were missing responses or more than one response were given for the same item. These questionnaires were withdrawn from the sample, and comprised 21 cases from the entire sample. The sample was thus reduced to 349 teachers, which was the total final sample used in the study. All the questionnaires were given a unique school and teacher identity, which was recorded, in order to track the questionnaires if queries arose.

The data from the 349 questionnaires were captured manually in *Microsoft Excel 2003* by a data capturer with 15 years experience in capturing data at a research institute. Acknowledging the probability of mistakes during the manual capturing process, the correctness of the captured data was checked by the researcher and the data capturer by comparing the captured form with the original for missing answers. This was followed by checking for instances where there were missing responses or more than one response were given for the same item. The data was then transferred to the database program *Statistica*. Thus, the data were entered twice in order to ensure that mistakes were avoided when data was entered, and thus to maximise the validity of the captured data.

The dataset was cleaned after the verification process, which entailed inspection of the frequencies of responses for each response category per item. Furthermore, the data

cleaning process involved checking the logic in the captured data by determining the frequency analysis per variable, as well as checking for apparent irregularities when compared to the responses on the NOIKQ. For those responses that were found to be outside the expected range, the original was checked and corrections were made to the data file.

Stage 5: Analysis of the NOIKQ (largely qualitative)

To recognise meaningful patterns in the data, descriptive statistics were used as a method to reduce the large amount of data to permit easy understanding and interpretation. A number of statistical analyses were performed during the analysis of the quantitative data. As a first step, data was used to perform a principal component factor analysis followed by varimax rotation. This was done in order to examine the validity of the NOIKQ in terms of the factor structure of the responses. The Cronbach alpha coefficient was used as an index of internal consistency reliability. Statistical parameters, correlations and chi-square test was used to compare the scores and response frequencies of different sample groups on individual items, and on the test as a whole. Correlations between individual items and on the test as a whole were computed for co-variation.

One-way ANOVA was performed to establish whether groups were different regarding the dependent variable. Each group was examined with the one-way ANOVA and variation was investigated with homogeneity of variance tests.

Simple correlations were used to examine the relationship between two or more variables, for example, the relationship between the different population groups and their understanding of IK.

The questionnaires also had open-ended questions. When analyzing the open-ended questions, the researcher applied the thematic approach (Boyatzis, 1998; Braun & Clarke, 2006; Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006; Terre Blanche, Durrheim, & Painter, 2006). After collecting the data, the analysis process was started by

transforming the qualitative data into numerical scores. Each significant statement (i.e., definition or parts of a definition) was labelled with the same code. After all the statements were coded, the codes were grouped by similarity, and a theme was identified and documented based on each grouping. The respondents' responses to the open-ended questions were categorized into themes. Two approaches were used in analyzing the open-ended responses. First, certain questions on the NOIKQ were used as themes, and the researcher simply looked for instances fitting the themes. For example, the respondents were asked what assistance was needed by them to implement Learning Outcome 3. Three themes, namely workshops, advisory assistance, and resources were identified, and the respondents' responses were placed in these themes. Second, the researcher studied the responses and looked for underlying principles that naturally underlie the responses. For example, in the section where the respondents were asked to mention the problems they faced in implementing the integration of scientific and indigenous knowledge, a number of themes emerged, such as resources, training received, and culture (lack of understanding of the different cultures by the teacher as well as a lack of tolerance for other cultures by the learners). The researcher then quantitized the themes (Tashakorri & Teddlie, 1998) by converting the narrative data into frequency counts (Miles & Huberman, 1994). That is, the themes (i.e., qualitative data) were transformed to numerical form (Onwuegbuzie & Teddlie, 2003) to indicate the number of definitions that contributed to each theme.

3.4.2 The second phase

During the second phase of the research study, quantitative and qualitative methods were used and took place in three stages. The quantitative data results were used as a point of departure for the second phase of data collection. An analysis of the results of the first phase indicated that the teachers did not implement Learning Outcome 3 as required by the new curriculum, because they had not been trained how to integrate indigenous knowledge into the science curriculum. Furthermore, the teachers indicated that they did not have an understanding of indigenous knowledge. To assist the teachers in their understanding of indigenous knowledge, the researcher designed resource material for a workshop where the teachers could be trained in how to integrate IK in the science

curriculum. To establish the effectiveness of the training the researcher used a quasi-experimental design. Details of the quasi-experimental design and development of the resource material and workshop will be described in stage six in the section which follows. Qualitative data were collected using classroom observations, as well as teacher and learner interviews and will be described in stage seven and stage eight describe the qualitative data analysis.

Stage 6: The quasi-experimental design

The design of the quasi-experimental design took place in three steps which are outlined as follows.

Step 1: The instructional design and planning of the workshop material

The respondents in the survey indicated that they did not receive training on how to integrate science and indigenous knowledge, and that they did not have sufficient knowledge of indigenous knowledge to teach this aspect confidently to their learners. The researcher chose a workshop as an intervention and continuing professional development of teachers to improve their teaching skills and developing new methods of teaching. The researcher preferred not to lecture to the teachers on IK but chose the workshop. In such a workshop the teachers could read and discuss the descriptions of IK and IKS and share their understanding of the key concepts with other teachers by working in pairs. The respondents' lack of understanding indigenous knowledge meant that resource material of indigenous knowledge had to be developed for the workshop. The researcher developed instructional activities on indigenous knowledge resource materials with tasks, activities, and resources which teachers could use in the classroom.

The content of the resource material developed by the researcher had to address issues such as the concepts indigenous knowledge and Western science, how to integrate science and indigenous knowledge in the classrooms, and resources with an indigenous content. Three drafts were written and revised. The resource material consisted of two resource

packs. The first resource pack was the material that was to be used for the workshop, and the second resource pack consisted of resource material suitable for the learners. The researcher was of the opinion that the topics that was to be covered in the workshop should be similar to those in the NOIKQ, where the teachers showed a lack of understanding. Thus, the content of the resource material for the workshop consisted of: an introduction of the different concepts of IK and western science, a series of 15 activities to develop an understanding of the different concepts, and suggested models to integrate scientific and indigenous knowledge. The resource material consisted of different activities, which included questions for discussion.

Next, since the resource material was ultimately designed for Life Sciences teachers and learners, the resource material was given to two Life Sciences Curriculum Advisors and to two experienced Life Sciences teachers to validate the IK content. These individuals were selected because of their expertise in Life Sciences. The teachers were both experienced and were Senior Certificate markers in Life Sciences. The Curriculum Advisors were Department of Education officials (i.e. in the Curriculum Support Service Directorate) and therefore knowledgeable about the requirements of the then new curriculum. The Curriculum Advisors and the science teachers were asked to assess whether the resource material covered what the curriculum required, as well whether it covered the grade level. They were also requested to read through the items covered in the resource material and to decide whether the items was relevant to subject teachers in the Western Cape Province, and if it was clearly expressed. The rationale for this request was IK was local knowledge and thus the resource should have relevant IK material for the Western Cape Province. These experts were also requested to give possible additional subject matter which was not covered in the resource material, and to provide a brief justification why the additional subject matter should be included. Both the Curriculum Advisors and the science teachers agreed with the IK content of the resource material. However, the Curriculum Advisors felt that the Learning Outcomes and Assessment Standards should also be included in the resource material of the teachers. These were consequently included in the resource pack of the teachers. This resource material is included in Appendix 7 (page 218).

Step 2: The design for the classroom observations

In a previous section (page 87), the researcher has shown that a workshop was chosen as an intervention to assist the teachers in their understanding of the concepts of Indigenous Knowledge and Western Science, as well as to integrate indigenous knowledge in the science curriculum. The next step was to observe the science teachers in the classroom teaching an integrated science indigenous knowledge lesson. However, to establish how effective the intervention was, the researcher chose a quasi-experimental design. Quasi experiments resemble true experiments in all aspects but cannot or do not use random assignment (Tredoux & Smith, 2006). In this quasi-experimental design, the researcher manipulates what the subjects will experience and one group of subjects is assigned to the intervention, whilst the other group receives no intervention at all.

The researcher purposefully selected 11 teachers to participate in the classroom observation. These teachers had participated in the survey and were selected for their particular interest in the research study. These classroom observations were to be video-taped. Video produces an enormous amount of data and are very time consuming to watch and transcription may take ten times the duration of the source tape (Jacobs, Kawanake & Stigler, 1999; Roschelle, 2000; Rostvall & West, 2005; Smith & Hardman, 2003). Therefore the researcher decided to keep the sample size manageable, and thus limit the sample size to 11 teachers. The researcher assigned the participants into groups that would receive the intervention (i.e., workshop) and those that would not have received the intervention (i.e., no workshop).

The randomisation process is a way of allocating the teachers to experimental and control groups randomly in an effort to make the groups equivalent. However, there was no randomisation, and thus the groups cannot be assumed to be equivalent because they will differ in many aspects. Therefore the researcher had to find manual ways to ensure that all the participants were equal. All the teachers were similarly uninformed about the integration of scientific and indigenous knowledge as well as their knowledge of indigenous knowledge. This was established from their answers from the NOIKQ questionnaire, which all the teachers who participated in the classroom observations,

completed. There was no major difference between the subjects of each group with regard to their understanding of indigenous knowledge before the experimental treatment began. All other variables were kept constant, thereby permitting a conclusive link to be drawn between the treatment and outcome variables.

The two-group design was used (Tredoux & Smith, 2006). This design involves two groups, with both groups being observed and video-taped (pre-observation). The one group was then exposed to the experimental treatment (workshop), and the other group was not exposed to the treatment. Both groups were then observed and video-taped after the completion of the experimental treatment (post observation). This design can be illustrated as follows:

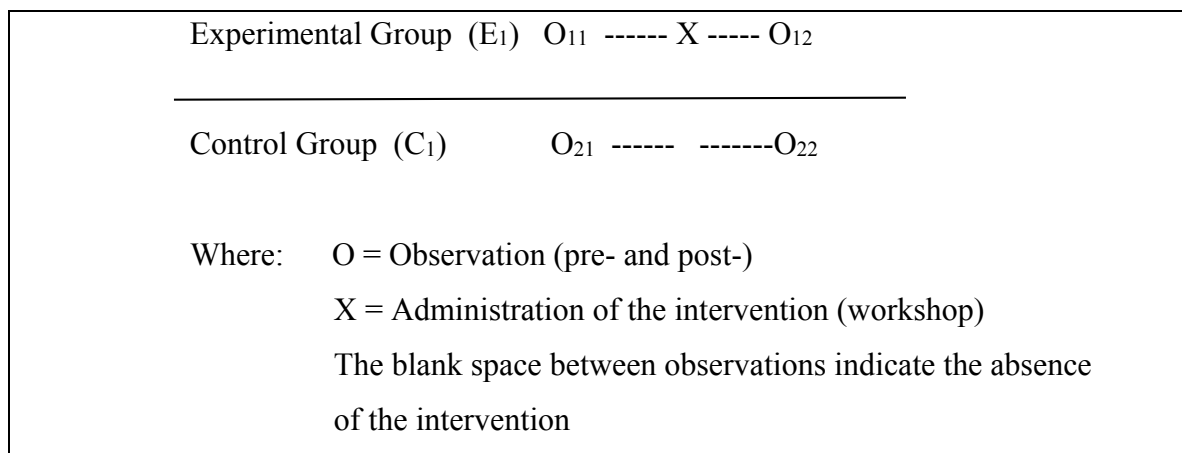


Figure 3.2 Diagrammatic representation of the quasi experiment design for the classroom observations (Adapted from Tredoux & Smith, 2006: 175).

Step 3: The workshop

The workshop was held at a school in Cape Town during October 2008. The program of the workshop is reproduced in Appendix 8 (page 264). The purposes of the workshop were to:

- a) introduce different concepts to teachers (e.g., indigenous knowledge, Western science);

- b) develop their understanding of various concepts of scientific and indigenous knowledge through a series of activities;
- c) provide suggestions through to which an integration of indigenous knowledge and Western science can occur in the classroom; and
- d) provide teachers with relevant IK resource materials for use in the classroom.

Five participants of the cases of eleven participated in the workshop.

Workshop activities were conducted with the teachers to discuss the concepts of scientific knowledge and indigenous knowledge, as well as making comparisons between various aspects of indigenous knowledge and scientific knowledge. This was followed with an explanation in the way in which indigenous knowledge could be integrated in the science curriculum. In discussing integration, the model of Ng'etich (1996), cited by Naidoo (2005), was explained. In this model three forms of pedagogical integration could be distinguished: firstly, IKS into Western science; secondly, IKS with Western science and, thirdly, IKS and Western science. The participants were also informed that the pedagogical model of Snively and Corsiglia (2001) could be used as a starting point in the preparation of their lessons.

The participants were informed that the models of integration were based on a major feature of constructivism, namely, that the prior knowledge of the learner was important. The four categories proposed by George (1999a) to consider in planning curriculum content integrating traditional knowledge and conventional science were also explained to the participants:

- A. **Category 1:** cultural knowledge can be explained in terms of Western science. For example, the practice of using lime juice and salt to remove rust stains from clothes can be explained in conventional scientific terms of reactions involving an acid, salt and oxide.
- B. **Category 2:** a conventional scientific explanation for cultural knowledge seems likely, but is not yet available.
- C. **Category 3:** a conventional scientific link can be established, but the underlying principles are different. For example, cultural knowledge states

that sugar causes diabetes while modern science claims then when one is diabetic; an intake of sugar can worsen the condition.

- D. **Category 4:** the cultural knowledge cannot be explained in conventional scientific terms. For example, there is no scientific explanation for the belief that hair will grow faster after being cut in the moonlight!

Some case studies as examples of indigenous knowledge in everyday situations were supplied and rehearsed. At the end of the workshop all participants were provided with resource materials for teachers as well as for learners.

After the workshop, qualitative data were collected and are described in the section which follows.

Stage 7: Collection of qualitative data

Qualitative data were collected in two steps which are discussed below.

Step 1: The classroom observations

Direct classroom observations were used as a qualitative data collection method in this research. According to Clough and Nutbrown (2002: 460), a working definition of observations is, “Simply looking - looking critically, looking openly, looking sometimes knowing what we are looking for, looking for evidence, looking to be persuaded, looking for information.” Cohen et al. (2007: 396), on the other hand, say that a feature of observations as a research process is that it offers the opportunity to gather ‘live’ data from naturally occurring social situations.

The purposes of the classroom observations were: a) to observe *first hand* what is happening in the classroom, and not relying on second-hand accounts where the teacher say what they do; b) to focus on *how* pedagogical integration of scientific and indigenous knowledge occurs; c) to record the *behaviour* of the teacher and the learners (e.g., the distinction between imported everyday knowledge and indigenous knowledge as well as

the learners' knowledge thereof); and d) to *confirm* or support data which had been collected during the quantitative data collection phase.

The foci of the observations were the pedagogical utilization of the resource material. Video observation was used in this research as a technique to capture what teachers actually do, as opposed to what they think they do, or would like others to think they do. To record these observations, the researcher used video because videos have the potential for overcoming subjectivity and bias on the part of the researcher (Cohen et al., 2007). The senior audio-visual technician at the University of Cape Town's School of Education was approached to video-tape the teachers while teaching indigenous knowledge lessons in the classroom. The researcher was an observer whilst the teachers were teaching a lesson of their design and choice with an indigenous content. The duration of each lesson was between 45-50 minutes, depending on the school.

There are degrees of participation in research (LeCompte & Preissle, 1993). The role of the researcher in this research was as observer-as-participant, where the researcher was known to the participants as a researcher who documented and recorded what was happening for research purposes. The researcher was present merely as an observer and a non-interventionist. According to Cohen et al. (2007: 397), "The researchers do not seek to manipulate the situation or subjects, they do not pose questions for the subjects, nor do they deliberately create new provocations."

Step 2: The interviews

The researcher interviewed teachers as well as learners. The purpose of the interviews was to clarify aspects observed during the classroom observations. Structured interviewing was used in this study. In the structured interview the wordings and questions were determined by means of a schedule and the content and procedures were organised in advance.

After considering several factors, such as the objectives of the interview, the researcher decided to use open-ended questions in the structured interviews. Open-ended questions

can be defined as “those that supply a frame of reference for respondents’ answers, but put a minimum of restraint on the answers and their expression” Cohen et al. (2007: 357).

Two sets of interviews were conducted in this research study. The purposes of the two sets of interviews differed and the interview questions for each set of interview differed.

The first set of interviews was the five teachers who attended the workshop. The researcher wanted to establish from the teachers:

- a. How the adoption of the teaching strategies in the workshop benefited or assisted the teachers in integrating scientific and indigenous knowledge.
- b. Whether their expectations were met in their self-selected scientific indigenous knowledge lessons.

The classroom observations took one week to complete. Therefore, the first teacher was interviewed one week after the observed lesson. Each interview, which lasted between 20-30 minutes, was held at the teacher’s school. The interview was tape-recorded and transcribed for later analysis. A copy of the interview questions for the teachers is attached in Appendix 9 (page 265).

One of the limitations of classroom observations that are video-taped concerns authenticity: does the observed lesson reflect what normally happens in the classroom? As experienced teachers we are aware that teachers will perform better if they know when they would be visit and thus rehearse a lesson with the class so that it may appear that they are excellent teachers. To find answers to this particular question, a second set of interviews was arranged and conducted with the learners.

The researcher approached teachers who participated in the classroom observations, and requested from them whether the researcher could choose twelve learners who could be interviewed. Criteria for selection for the learners who were to be interviewed included: children who were not shy, children who would not feel uncomfortable or threatened when being interviewed, children that do not tell lies or will say anything if they feel that they

do not know the answer (Le Compte & Preissle, 1993). The teachers were asked that, after learners were identified, permission must be obtained from the learners' parents for their consent for their children to be interviewed. A letter asking for permission for the children to participate in the research was given to the parents (Appendix 10, page 268). All the parents who were approached by their children gave their written consent for their children to be interviewed by the researcher.

All the interviews took place on school premises during school hours. The interview sessions were scheduled in such a way as not to disrupt the learners' school work or the school programme. This resulted in the interview being conducted during the Life Sciences teacher's (who was observed earlier) period. Twelve learners (six boys and six girls) were interviewed once during the researcher's period of observation at the school.

On the day of the interview of the learners, the researcher introduced himself to the participants. The researcher explained to the participants what would be involved during the interview process, and their confidentiality and anonymity were guaranteed by the researcher. Because the participants were to be asked questions regarding the lesson that was video-taped, their teacher was not present in the room where the interviews were held. The researcher assumed that in this manner the participants could reveal what they really felt and thought.

The researcher wanted to put the participants at ease and help them feel confident. This was done in a manner where the researcher spoke in general about their school and what they intended to study when they had completed their secondary schooling. The researcher did not give any specific details of the study. The researcher also wanted to make the interview non-threatening and enjoyable. All the interviews lasted between 15-20 minutes. The interview was tape-recorded and transcribed for later analysis. A copy of the interview questions for the learners is included in Appendix 11 (page 269) and Appendix 12 (page 270).

Stage 8: Analysis of the qualitative data

When analyzing the qualitative data gathered through classroom observations as well as through teacher and learner interviews, the researcher applied a thematic approach (Boyatzis, 1998; Braun & Clarke, 2006; Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006; Terre Blanche, Durrheim, & Painter, 2006). The five-step model for integrating science and indigenous knowledge of Snively and Corsiglia (2001) was used as themes to guide the search for common patterns of the classroom practices. Each step of the five-step model of Snively and Corsiglia (2001) was identified as a theme. From these five themes 11 sub-themes were developed. Each of these 11 sub-themes was given a rating code of one to three, which served as an indicator of the link to the theme. The researcher applied narrative stories (Lincoln & Guba, 1985; Powell, Francisco, & Mahrer, 2003) to report the findings (Chapter 4). The narrative stories were used to combine the data from the classroom observations and the teacher and learner interviews. The researcher used the video data, as well notes from the classroom observation to award the teacher a value between one and three to indicate the level of integration of IK into science. The narrative data was converted into rating scales of one to three points to indicate the level of implementation of IK in the science curriculum. Some of the teachers who were observed were exposed to an intervention, whilst others were not exposed to the intervention. The manner in which the researcher presents the narrative stories is as follows. Firstly, each teacher is presented as a case to illuminate important findings about that particular teacher. Secondly, the different cases are compared to illustrate contrasts and contradictions between the teachers. The narrative stories are followed by an interpretive commentary based on the classroom observations and teacher and student interviews.

3.5 Chapter summary

In the present study, the sequential multi-method research design was used, which combine different methods or approaches in a single study that are not integrated until inferences are being made (Johnson, Onwuegbuzie & Turner, 2007; Morse, 2003). This

contemporary research approach was employed to triangulate the quantitative findings with the qualitative findings, so that the study can provide trustworthy and credible answers to the research questions.

For the QUAN phase, a newly adapted questionnaire, the *Nature of Indigenous Knowledge Questionnaire* (NOIKQ), was used to assess high school science teachers' understanding of indigenous knowledge, as well as the problems teachers encounter in their classroom implementation of Learning Outcome 3. Three of the sections of the NOIKQ was adopted and developed from the Nature of Science and Nature of Indigenous Knowledge (NOSNIK) questionnaire. The NOSNIK was purposefully chosen because it was developed to assess the teachers' knowledge, understanding, and views of the Nature of Science and Indigenous Knowledge, as well as the teachers' views on the integration of science and IKS in the classroom. Aspects related to whether the teachers received training on Indigenous Knowledge, as well as the problems teachers encounter in the integration of scientific and indigenous knowledge was developed especially for the present study.

After the pilot study and subsequent modifications to the questionnaire were completed, data were collected from 370 teachers from urban and public schools in the Western Cape Province, South Africa. Convenience and purposeful sampling was used to select the sample of teachers. After the data collection, the data were first captured, cleaned, and then analysed. Statistics was used as a method to reduce the large amount of data to permit easy understanding and interpretation.

The survey questionnaire (NOIKQ) was used to collect data to answer research question one (i.e., to what extent are the teachers in the Western Cape integrating IK and scientific knowledge) and research question two (i.e., what are the teachers' views of the nature of science and indigenous knowledge and how the two worldviews can be integrated in the science classroom). A number of statistical analyses were performed during the analysis of the quantitative data. Statistical parameters, correlations and chi-square test was used to compare the scores and response frequencies of different sample groups on individual

items, and on the test as a whole. Correlations between individual items and on the test as a whole were computed for co-variation.

One-way ANOVA was performed to establish whether groups were different regarding the dependent variable. Each group was examined with the one-way ANOVA and variation was investigated with homogeneity of variance tests.

Simple correlations were used to examine the relationship between two or more variables, for example, the relationship between the different population groups and their understanding of IK.

The questionnaires also had open-ended questions. When analyzing the open-ended questions, the researcher applied the thematic approach (Braun & Clarke, 2006; Crabtree & Miller, 1999; Terre Blanche, Durrheim, & Painter, 2006). After collecting the data, the analysis process was started by transforming the qualitative data into numerical scores. Each significant statement (i.e., definition or parts of a definition) was labelled with the same code. After all the statements were coded, the codes were grouped by similarity, and a theme was identified and documented based on each grouping. The respondents' responses to the open-ended questions were categorized into themes. The researcher then quantitized the themes (Tashakorri & Teddlie, 1998) by converting the narrative data into frequency counts (Miles & Huberman, 1994). That is, the themes (i.e., qualitative data) were transformed to numerical form (Onwuegbuzie & Teddlie, 2003) to indicate the number of definitions that contributed to each theme.

The analysis of the quantitative data revealed that the teachers were not trained in integrating Indigenous Knowledge in the Science curriculum, did not have an understanding of Indigenous Knowledge, and did not have resource material to teach Indigenous Knowledge. Eleven teachers were purposely chosen to participate in an intervention, where the teachers were trained in how to integrate science and Indigenous Knowledge. To determine the effectiveness of the intervention, a quasi-experimental design, where a sample of the teachers was exposed to the intervention whilst another sample was not exposed to the intervention, was employed.

Classroom observations, as well as teacher and learner interviews were chosen as data collection methods in the qualitative phase of the study. These data collection strategies were used to answer research question three (i.e., how effective was the intervention) and research question four (i.e., to what extent can the model of Snively and Corsiglia be useful for measuring change). Resource material was developed with tasks and activities which the teachers could use in their classroom. The qualitative data were analysed using a thematic approach. Each step of the five-step model for integrating IK and science of Snively and Corsiglia (2001) were used as themes. Narrative stories were used to combine the data from the classroom observations and the teacher and learner interviews.

Chapter 4 describes the results, and follows next.

CHAPTER 4

RESULTS

4.1 Introduction

The objectives of this study were stated in Chapter 1 (page 8) as well as the research questions in Chapter 1 (page 8). The previous chapter provided details of the research design (page 63), as well as the development (page 72) and administration of the *NOIKQ* (page 79), which was used to collect quantitative data from 349 teachers from eighty schools. The aim of the quantitative phase was to establish the teachers' understanding of indigenous knowledge, and the problems they encountered in their integration of science and indigenous knowledge in the classroom. The information from the quantitative data was used as a point of departure for the collection of qualitative data. In this chapter the results and findings of this research study is presented in two parts. In Part A, results from the analysis of the quantitative data using the *NOIKQ* is reported. In Part B, the findings of the qualitative data collected by means of classroom observations and interviews are described.

PART A: Findings from the quantitative data

In this part, the results are presented in two sections. Firstly, hypotheses are tested and presented. The repeated null hypothesis to be tested is that no significant differences will occur between the expressed opinion of the respondents and the different demographic factors. Secondly, the questionnaires also had open-ended questions. When analyzing the open-ended questions, the researcher applied the thematic approach, as described in Chapter 3 (page 93). After the quantitative comparisons, classification of the open-ended responses of the *NOIKQ* is made using emerging themes, categories, and patterns.

4.2 The nature of indigenous knowledge of the teachers (as determined by the *NOIKQ*)

Three hundred and forty nine high school teachers completed the *Nature of Indigenous Knowledge* (NOIKQ) questionnaire. The biographical descriptions of the respondents are described below:

Table 4.1 Demographic information of the participants of the NOIKQ (n = 349)

Demographic factor	Descriptor	Total	Percentage
Gender	Male	157	45
	Female	192	55
Home Language	English	157	45
	Afrikaans	133	38
	Xhosa	59	17
Population Group	Black	66	19
	Coloured	157	45
	White	98	28
	Indian	28	8
Religious Group	Christian	318	91
	Muslim	31	9
Learning Area Taught	Life Science	195	56
	Natural Science	154	44
Teaching Experience	Less than 1 year	19	5
	1-5 years	65	19
	6-10 years	70	20
	More than 10 years	195	56
Qualifications	No Matric	4	1
	REQV 10	0	0
	REQV 11	56	16
	REQV 12	0	0
	REQV 13	0	0
	REQV 14	223	64
	REQV 15	0	0
	REQV 16	66	19

4.3 Presentation of the quantitative findings: hypotheses testing.

For the analysis for the hypotheses testing, the independent variables are the:

- i) gender of the respondents;
- ii) population group of the respondents;
- iii) language of the respondents;
- iv) educational qualification of the respondents;
- v) religious group of the respondents;
- vi) learning area taught by the respondents; and
- vii) total teaching experience of the respondents.

The **dependent variables** are the responses of the different parts of the questionnaire, for example B1, B2, B3, etc.

The repeated **null hypothesis** to be tested for each dependent variable against the independent variable is that, when rating the opinion of a given response, no significant differences will occur between the expressed opinions of the respondents of the different demographic factors.

4.3.1 Correlations in questions B2-B7

For the analysis of questions B2 to B7 of part B of the questionnaire, a score of zero to three was awarded for the responses of the respondents. A score of zero was awarded when no response was provided; a score of two was awarded if an explanation as an answer was provided, but no example was provided; and a score of three was awarded when an explanation as well as an example was provided by the respondents.

The hypotheses stated that in part B, teachers who tend to score high scores on one question will tend to score high scores on all the other questions; and teachers who tend

to score low scores on one question will tend to score low scores on all the questions. The analysis excludes the yes/no response in B1.

Table 4.2 records the significant correlations for the responses of the questions B2-B7. The hypothesis is supported with the exception of the responses to question B7, associated to questions B2 and B3.

Table 4.2 Correlations for questions B2-B7 (n = 349)

Variable	Mean	SD	B2	B3	B4	B5	B6
B2	2.38	0.78	1.00				
B3	2.53	0.59	0.63	1.00			
B4	2.18	0.64	0.31	0.44	1.00		
B5	1.95	0.73	0.24	0.29	0.48	1.00	
B6	1.84	0.90	0.17	0.22	0.49	0.57	1.00
B7	0.48	0.86	0.08	0.02*	0.13	0.22	0.27

* Correlations significant at $p < 0.05$

As shown in Table 4.2, generally there is a positive correlation for questions B2-B7. However, the correlation is much stronger in B2 and B3, followed by B5 and B6. Therefore, the respondents who answered question B2 (scientific knowledge) could also answer question B3 (indigenous knowledge). If a respondent could not answer question B2, they may not be able to answer question B3. The respondents who answered question B5 (what scientific knowledge and indigenous knowledge had in common) could also answer question B6 (how to 'bridge' indigenous knowledge and scientific knowledge). If a respondent could not answer question B5, they may not be able to answer question B6. According to Table 4.2, the mean scores suggests that the respondents could, generally, answer the questions B2-B6 fairly well, obtaining a score of more than 50%.

4.3.2 Responses to the questions in part B

Table 4.3 presents a summary of the response scores for the different demographic factors with regard to question B2-B6.

The hypothesis stated that there will be no significant differences amongst the responses of the respondents of the different demographic factors in their achievement scores and the questions B2, B3, B4, B5, and B6.

Table 4.3 Summary of the response scores for questions B2-B6 (n = 349)

Demographic factor	B2	B3	B4	B5	B6
Gender	0.15	0.81	0.28	0.95	0.90
Learning area	0.60	0.55	0.22	0.05	0.07
Population	0.02 *	0.20	0.01*	0.15	0.00 *
Qualification	0.24	0.04 *	0.88	0.05	0.08
Language	0.27	0.69	0.67	0.01*	0.02 *
Religion	0.35	0.40	0.26	0.82	0.82
Experience	0.35	0.76	0.30	0.27	0.16

*p < 0.05 shows significant differences

As shown in Table 4.3, the hypothesis cannot be rejected for the demographic factors *gender*, *learning area*, *religion* and *experience* of the teachers. There was a statistically significant difference ($p < 0.05$) between the responses of the respondents for the demographic factors *population groups*, *qualifications* of the teachers, and *home language* of the teachers for questions B2-B6. To determine the highest and lowest achievers in the instances of significance, cross tabulations were completed. Table 4.4 presents a summary of the cross tabulations for questions B2-B6 of the respondents of those demographic factors which had a statistically significant difference.

Table 4.4 Summary of the responses (in percentages) for the cross tabulations for questions B2-B6

Demographic Factor		B2			B3			B4			B5			B6		
		0	2	3	0	2	3	0	2	3	0	2	3	0	2	3
Population	Coloured	9	45	46	1	48	51	7	68	25	11	76	13	16	69	15
	White	1	40	59	1	34	65	0	63	37	6	73	21	12	62	26
	Black	9	46	45	1	45	54	4	72	24	14	76	10	28	62	10
	Indian	3	42	55	7	41	52	4	86	10	7	83	10	10	76	14
Language	English	7	37	56	3	37	60	3	69	28	5	76	19	12	64	24
	Afrikaans	4	49	47	1	48	51	5	67	28	13	75	12	18	69	13
	Xhosa	10	48	42	2	44	54	5	72	23	15	75	10	26	66	8
Qualification	No matric	0	100	0	0	100	0	33	33	33	33	67	0	33	33	33
	REQV 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REQV 11	7	48	45	4	50	46	11	68	21	16	73	11	23	66	11
	REQV 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REQV 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REQV 14	7	45	48	1	44	55	4	72	24	9	76	15	16	69	15
	REQV 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REQV 16	5	32	63	2	29	69	2	58	40	3	78	18	12	57	31

In the analysis of the cross tabulations for questions B2-B6, the researcher established the highest achiever for a particular question by first establishing the responses of those respondents who answered the question and provided an example (e.g., obtaining a score of three). If the number of respondents who obtained a score of three was approximately similar, then the researcher considered the number of those respondents who answered the question but did not provide an example (e.g., obtained a score of two). If the number of respondents who obtained a score of two or three was approximately similar, the researcher then considered the number of respondents who did not answer the question (e.g., obtained a score of one).

The sections that follow will discuss only those questions where there was a statistically significant difference, namely B2, which relates to scientific knowledge (*population group* of the teachers); B3, which relates to indigenous knowledge

(*qualification* of the teachers); B4, which relates to similarities between science and indigenous knowledge (*population group* of the teachers); B5, which relates to the difference between science and indigenous knowledge (*language* of the teachers); and B6, which relates to how the teachers ‘bridge science and indigenous knowledge (*population group* of the teachers as well as the *language* of the teachers).

a) *Population group*

As shown in Table 4.4, in question B2, the White teachers (59%) were the highest achievers with regard to their knowledge about scientific knowledge compared to the other population groups. The Black teachers and the Coloured teachers had approximately the same scores. Consequently the Black teachers and the Coloured teachers were the lowest achievers with regard to their knowledge about scientific knowledge. In question B4, Table 4.4 shows that the White teachers (37%) were the highest achievers with regard to their knowledge about the differences between indigenous knowledge and scientific knowledge compared to the other population groups. The Coloured teachers were the lowest achievers because they obtained the lowest score for this question as compared to the other population groups. In question B6, the White teachers (26%) were the highest achievers and the Black teachers were the lowest achievers with regard to how they “bridged” the two worlds of scientific knowledge and indigenous knowledge in the classroom compared to the other population groups. As shown in Table 4.4, the Black teachers were the lowest achievers because they obtained the lowest score for this question as compared to the other population groups.

b) *Home language*

As shown in Table 4.4, in question B5, the English speaking teachers (19%) were the highest achievers with regard about their knowledge on what scientific knowledge and indigenous knowledge had in common. The Afrikaans speaking teachers as well as the Xhosa speaking teachers had approximately similar scores and the Xhosa speaking

teachers and the Afrikaans speaking teachers is considered to be the lowest achievers for question B5. In question B6, the English speaking teachers (24%) were the highest achievers with regard to how they “bridged” the two worlds of scientific knowledge and indigenous knowledge in the classroom. The Afrikaans speaking teachers as well as the Xhosa speaking teachers had approximately similar scores. However, the Xhosa speaking teachers is considered to be the lowest achievers for question B6 because of their higher percentage of no responses by the respondents.

c) *Qualification*

As shown in Table 4.4, in question B3, the REQV 16 teachers (69%) were the highest achievers; the REQV 14 teachers (55%) were the second best achievers; and the REQV 11 teachers (46%) were the lowest achievers with regard about their knowledge of indigenous knowledge compared to the qualifications of all the teachers in this study.

In conclusion, for the responses of part B, the purpose of the questions in part B was to establish the teachers’ knowledge, understanding and views of science and IKS. The results have shown that the teachers generally could define scientific knowledge and indigenous knowledge as well as to provide examples of the two knowledge systems. Furthermore, the White teachers were the highest performers in all the questions in part B whilst the Coloured teachers and Black teachers performed the weakest in all questions in part B.

To assess the teachers’ presuppositions and perceptions of science and IKS, the respondents completed part C1 of the questionnaire. The section that follows describes the teachers’ responses of their view on the nature of science and IKS.

4.3.3 Responses to question C1

The survey questionnaire contained six items concerning IKS, seven items concerning science and five items concerning IKS and science. The teachers had to indicate, on the survey questionnaire, the items that belonged to IKS, the items that belonged to science and the items that belonged to IKS items and science. In the analysis of this section, each correct answer was awarded one mark. The number of correct responses for IKS and science was determined by the statistical package *Statistica*. Table 4.5 and Table 4.6 represent the distribution of the total correct scores for IKS and science items respectively.

Table 4.5 Distribution of the scores total of 349 participants of their correct answers for IKS items

Number of correct answers	Number of teachers
0	87
1	73
2	57
3	77
4	37
5	15
6	3

According to Table 4.5, the distribution of correct answers for IKS items was skewed towards the lower marks. Twenty five percent of the teachers did not have one correct answer for IKS items, whilst twenty one percent of the teachers obtained only one correct answer for the IKS items. Furthermore, less than one percent of the teachers obtained all six answers for IKS items correct. According to Table 4.6, the trend in the scores for the correct answers for science items indicates a tendency towards normal distribution. Five percent of the teachers did not have one correct answer for the science items. The number of teachers with correct answers for science items increased until the teachers obtained four out of the seven science items correct. Thereafter the

number of teachers obtaining correct answers for science items decreased. Less than one percent of the teachers obtained all seven answers for science items correct.

Table 4.6 Distribution of the scores total of 349 participants of their correct answers for science items

Number of correct answers	Number of teachers
0	18
1	40
2	62
3	70
4	71
5	63
6	22
7	3

A one-way analysis of variance (ANOVA) with demographic factor as independent variable was used to determine to distinguish between the respondents of the different demographic factors. In reporting the ANOVA, only the p-values were indicated. Table 4.7 represents a summary of the one-way ANOVA for the IKS and science items in C1.

a) Discussion on IKS items

As shown in Table 4.7, there was a statistically significant difference ($p < 0.05$) between the responses of the respondents of the demographic factors *population groups*, *qualifications*, *home language*, *religion* of the teachers, as well as *experience* for the number of correct answers for IKS items. To determine the highest and lowest achievers in the instances of significance, cross tabulations were completed. Table 4.8 presents a summary of the cross tabulations for the correct answers for the IKS items.

The discussion that follow will only discuss the demographic factors which showed a significant difference, namely, *population groups*, *qualifications*, *home language*, *religion* of the teachers, as well as *experience*.

As shown in Table 4.8, the Indian teachers were the highest achievers for the percentages of the number of correct answers for the IKS items because the Indian teachers obtained a higher percentage of correct answers as compared to the other population groups. The Coloured population group was the lowest achievers for the number of correct answers for the IKS items because of the high percentage (34%) of teachers who obtained a score of zero.

With regard to the *language* of the teachers, the Xhosa speaking teachers was the highest achievers for the number of correct answers for the IKS items; the English speaking teachers obtained the second highest correct answers for the IKS items, whilst the Afrikaans speaking teachers was the lowest achievers for the number of correct answers for the IKS items because of the high percentage (35%) of teachers who obtained a score of zero.

Table 4.7 Summary of the scores for one-way ANOVA for IKS and science items

Demographic factor	IKS Total	Science Total
Gender	0.865	0.246
Learning area	0.051	0.102
Population group	0.000*	0.005*
Qualification	0.046*	0.684
Language	0.001*	0.600
Religion	0.001*	0.010*
Experience	0.001*	0.001*

* $p < 0.05$ shows significant differences

An inspection of Table 4.8 shows that the Muslim teachers obtained a higher percentage of correct answers, from three until six, than the Christian teachers. Therefore the Muslim teachers were the higher achievers for the number of correct answers for the IKS items, whilst the Christian teachers were the lowest achievers for the number of correct answers for the IKS items because of the high percentage (26%) of teachers who obtained a score of zero.

Table 4.8 Summary of the cross tabulation for the correct answers for the IKS items

Demographic Factor		Number of correct answers (as a percentage)						
		0	1	2	3	4	5	6
Population	Coloured	34	25	15	16	6	3	1
	White	26	23	12	20	14	4	1
	Black	13	14	27	25	16	4	1
	Indian	3	11	11	55	10	10	0
Home Language	English	21	24	14	25	11	4	1
	Afrikaans	35	21	15	17	7	4	1
	Xhosa	13	13	25	25	18	5	2
Religious Group	Christians	26	22	17	19	11	4	1
	Muslims	6	13	13	50	9	9	0
Teaching Experience	< 1 year	11	17	18	24	18	12	0
	1-5 years	16	17	9	36	20	2	0
	6-10 years	18	18	23	24	13	3	1
	>10 years	32	23	16	17	6	5	1
Qualification	No matric	67	33	0	0	0	0	0
	REQV 10							
	REQV 11	34	16	14	23	11	2	0
	REQV 12							
	REQV 13							
	REQV 14	21	21	19	21	11	6	1
	REQV 15							
	REQV 16	28	23	15	25	9	0	0

With regard to teaching experience, those teachers who had less than one year teaching experience had the highest number of correct answers for IKS items, whilst those teachers with more than ten years teaching experience received the lowest number of correct answers (32%) for the IKS items. As shown in Table 4.8, the percentages of the number of correct answers for the IKS items by the REQV 14 and REQV 16 teachers were comparatively the same. A further inspection of Table 4.8 shows that the REQV

14 teachers obtained a higher percentage of correct answers, from three until six, than the REQV 16 teachers.

Therefore the REQV 14 teachers were the highest achievers for the number of correct answers for the IKS items, whilst the REQV 16 teachers were the second highest achievers for the number of correct answers. Those teachers with no matric received were the lowest achievers for the number of correct answers for the IKS items because of the high percentage (67%) of teachers who obtained a score of zero.

b) Discussion on science items

According to Table 4.7, there was a statistically significant difference ($p < 0.05$) between the responses of the respondents of the demographic factors *population groups*, *religion* of the teachers, as well as *experience*, for the number of correct answers for the science items.

Table 4.9 Summary of the cross tabulations for the correct answers for the science items

Demographic Factor		Number of correct answers (as a percentage)							
		0	1	2	3	4	5	6	7
Population	Coloured	7	13	21	21	21	12	4	1
	White	4	11	15	14	21	25	9	0
	Black	4	12	16	28	18	15	4	1
	Indian	0	3	14	17	21	34	10	0
Religious Group	Christians	6	12	18	20	21	16	6	1
	Muslims	0	3	16	19	19	34	9	0
Teaching Experience	< 1 year	12	12	18	35	24	0	0	0
	1-5 years	2	3	14	20	22	27	13	0
	6-10 years	6	4	24	20	25	17	4	0
	>10 years	6	17	17	19	18	17	6	2

To determine the highest and lowest achievers in the instances of significance, analysis of variance (ANOVA), as well as cross tabulations were completed. Table 4.9 represents a summary of the cross tabulations for the correct answers for the science items.

As shown in Table 4.9, the percentages of the number of correct answers for the science items by the Indian and White population group teachers in this study were comparatively the same. The Black and Coloured population group teachers in this study obtained approximately similar scores. However, an inspection of Table 4.9 shows that the Black teachers performed marginally better than the Coloured teachers because the Black teachers had a higher percentage of correct answers from a score of three and upwards to a maximum of seven. Thus, the Coloured teachers were the lowest achievers for the number of correct answers for the science items. Table 4.9 also show that the Muslim religious group had the highest number of correct answers for science items, whilst the Christian teachers received the lowest number of correct answers for the science items.

With regard to teaching experience, Table 4.9 shows that those teachers who had one to five years teaching experience had the highest number of correct answers for science items, whilst those teachers with less than one year teaching experience received the lowest number of correct answers for the science items.

In part B it was shown that the respondents in this could define IKS and science and provided examples of both knowledge systems. The respondents could also mention the differences as well as what the two knowledge systems had in common. In this section the respondents had to apply their knowledge in IKS and science. The results have shown that a high percentage of the respondents (25%) could not obtain one correct answer out of six for IKS items. The respondents in this study therefore had an insufficient knowledge of IKS.

4.3.4 The instructional method to integrate IKS and science

Learning Outcome 3 of the RNCS and NCS necessitates that teachers are able to formulate and implement teaching strategies to integrate the IKS in the science curriculum in the classroom in a holistic way. Question C2 on the survey questionnaire contained 11 instructional methods to integrate IKS and science in the classroom which the teachers had to rank from the most important (=1) to the least important (=11). Table 4.10 presents the different instructional methods (indicated as item number), mean, minimum and maximum scores, and standard deviations obtained with the 349 teachers.

As shown in Table 4.10, there were not huge differences in the scores for the ranking of the different instructional methods. The mean scores obtained by the teachers were used to rank the instructional methods chosen by the teachers from the most important to the least important. The lowest mean score obtained was ranked as the number one or most important instructional method; the second lowest mean score is the number two instructional method. The highest mean score was ranked as the least important instructional method. Table 4.11 represents a summary of the rankings of the instructional methods, ranked from most important to the least important, as chosen by the 349 teachers.

As shown in Table 4.11, the most important instructional method chosen by the teachers in this study is to start the lesson with the prior ideas of the learners; involving the learners actively in problem-solving activities; and using a holistic and integrated instructional approach. Furthermore, the teachers reject the idea that IKS is concerned with the spiritual world. These are important aspects and will be discussed in detail in Chapter 5.

Table 4.10 Summary statistics for the scores of the 349 teachers on the instructional method, item by item

Item number	Valid N	Mean	Minimum	Maximum	SD
1	349	5.65	1.00	11.00	2.99
2	349	5.20	1.00	11.00	3.06
3	349	6.34	1.00	11.00	3.03
4	349	5.18	1.00	11.00	3.24
5	349	5.50	1.00	11.00	2.99
6	349	4.21	1.00	11.00	2.93
7	349	6.12	1.00	11.00	2.93
8	349	7.04	1.00	11.00	3.09
9	349	7.19	1.00	11.00	2.99
10	349	7.05	1.00	11.00	2.84
11	349	6.22	1.00	11.00	3.18

Table 4.11 Teachers' rankings of the most important instructional methods for the integration of science and indigenous knowledge

Item	Instructional method for integrating science and indigenous knowledge	Rank*
6.	Starting lessons with learners' ideas before presenting the scientific view.	1
4.	Involving learners actively in problem-solving activities.	2
2.	Using a holistic or an integrated instructional approach.	3
5.	Developing or extending lessons to include current issues such as HIV/AIDS, genetic engineering, drugs and sports, cloning, etc.	4
1.	Frequent use of provocative, argumentative, or inquiry-based questions.	5
7.	Extending science classroom discussions to include the IKS modes of inquiry, e.g. inviting IKS experts into class on some topics.	6
11.	Emphasize cooperative learning rather than competitive learning.	7
3.	Emphasizing 'showing' or modeling rather than lecturing.	8
8.	Avoid presenting indigenous knowledge as primitive science that is under development.	9
10.	Assess each knowledge claim with its own assumptions and standards rather than using science to judge indigenous knowledge as true or false.	10
9.	Reject the claim that science works in the physical world while indigenous knowledge is only concerned with the social and spiritual worlds.	11

* (most important = 1 to least important = 11)

4.3.5 Integration of IK in science curriculum

Learning Outcome 3 (LO3) of the Revised Curriculum Statement policy document of the Department of Education (2002) expects the teacher to integrate IK in the science curriculum. The respondents were asked whether they included LO3 in their lessons. A little more than half (53%) of the respondents indicated that they included LO3 in their lessons, whilst 47% of the respondents indicated that they did not include LO3 in their lessons. Thus, a high percentage of the teachers in this study did not integrate IK and science, as required by the Department of Education, in their science lessons. The reasons for this lack of integration of IK and science by the teachers will be discussed in detail in Chapter 5.

4.4 Presentation of the qualitative results (pertaining to the NOIKQ)

This section presents an analysis of the 349 participants' written comments for Part B and Part D on the NOIKQ. For the analysis of section 4.2.1 up to 4.2.7, which follow below, the researcher used the same method. The researcher meticulously checked the response of each teacher for that particular question (i.e., on their understanding of scientific knowledge; their understanding of IK; understanding of the differences between science and IK; what science and IK had in common; how science and IK are “bridged” in the classroom; the usefulness of textbooks; problems faced in implementing LO3; and assistance needed). Similar responses, which represented a theme, were all grouped together. To ensure each group represented a similar theme, a content word or words were selected so that a theme could easily be identified. After checking and re-checking each group, each theme was finalised and the number of each group of responses counted. The frequency of the content word(s) mentioned was arranged in descending order to illuminate the most important word(s). The content word(s) and the frequency it was mentioned was then tabulated. Illustrative responses mentioned by the teachers on the feedback survey are also shown. Although it is the researcher's wish to show all the responses, it would not be possible to do so because of the huge amount of data collected on the NOIKQ. Thus, only a few illustrative examples of the written comments are also included, which can be considered as representative of the responses.

Note: The illustrative examples of the cited comments written by the teachers in the sections that follow are reproduced *verbatim*

The sections which follow will describe the responses by the teachers.

4.4.1 Teachers' understanding of scientific knowledge

In question B2 respondents were asked what ‘scientific knowledge’ was. Table 4.12 presents some of the content words mentioned by the teachers on the NOIKQ

questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.12 Content words mentioned for scientific knowledge

Content word(s)	Frequency mentioned
Proven	78
Testing	69
Experimentation	54
Scientific fact	45
Evidence	38
Involves research	32
New discoveries	14
Academic arguing	8

- Theories that have been *tested* using sound scientific method (many times) and *proven sound* in many different circumstances.
- Knowledge that has been investigated, *researched*, tested, etc.
- Knowledge about how the world works on any level. This is also knowledge usually gained through *academic learning*.

As shown in Table 4.12, most of the responses of the teachers included the descriptions “proven,” “tested” and “experimentation”. Many of the teachers therefore subscribe to the traditional largely empiricist understanding, namely that science is made up of provable truths, unfettered with belief and dealing only with tangible reality (Ogunniyi, 2009a). However, scientific knowledge is not provable or verifiable, but is testable, confirmable, and falsifiable or can attain a high degree of credibility (Ogunniyi, 2009b).

4.4.2 Teachers’ understanding of indigenous knowledge

In question B3 the respondents were asked what ‘indigenous’ knowledge was. Table 4.13 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.13 Content words mentioned for indigenous knowledge

Content word(s)	Frequency mentioned
Not proven	65
Exist locally	58
Belief of cultural groups	56
Taught by elders	48
Not scientific	36
Developed over generations	24
How the world works	13
From forefathers	8

- Things that people that belong to a certain *culture* have in common.
- Knowledge that originates with a *certain group* of people that comes about from living in an area for a *long time*.
- *Cultural* beliefs and knowledge passed from *generation* to generation.

As shown in Table 4.13, most of the responses of the teachers included the descriptions “not proven,” “exists locally,” and “beliefs of cultural groups.” The teachers did not define indigenous knowledge but subscribed to the characteristics of indigenous knowledge.

4.4.3 Teachers understanding of the differences between scientific knowledge and indigenous knowledge

In question B4 respondents were asked what distinguished ‘scientific’ knowledge from ‘indigenous’ knowledge. Table 4.14 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.14 Content words mentioned to distinguish scientific knowledge from indigenous knowledge

Content words		Frequency mentioned
Scientific knowledge	Indigenous knowledge	
Repeatedly tested/proven	Not tested/proven	84
Universal/ international	Local	69
Learnt at school	Learnt at home	54
Facts from laboratory	From nature	48
Researched	Application of knowledge	33
Changes	Fixed	24

- Scientific knowledge has been *proved*. Indigenous knowledge is *hearsay*- in some instances we were told to believe that it works.
- Scientific: *testable*, proved formally e.g. experiment. Indigenous: may be passed on by word of mouth, *learnt* from previous generations, may be influenced by cultural beliefs.
- Scientific knowledge is *studied* and proven with experiments and factually backed up. Indigenous knowledge is *not* widely *known* or used.

As shown in Table 4.14, most of the responses of the teachers included the description that scientific knowledge is “proven” and “known worldwide” whilst indigenous knowledge is mostly “not proven” and “local”. This indicates that the respondents subscribe to a faulty notion about science and indigenous knowledge.

4.4.4 Teachers understanding of what scientific knowledge and indigenous knowledge have in common

In question B5 respondents were asked what ‘scientific’ knowledge and ‘indigenous’ knowledge had in common. Table 4.15 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.15 Content words mentioned to describe what scientific knowledge and indigenous knowledge had in common

Content word(s)	Frequency mentioned
Originate from observation and experimenting	67
Both have cure for diseases	58
Both are useful	43
Knowledge acquired over time	27
Both related to knowledge	23
Both create some research	18
Both obtained by trial and error	18
They both offer explanations of phenomena	12

- They both offer *explanations* for phenomena.
- Both related to *knowledge*; both come about by observation; and both are useful to humans.

As shown in Table 4.12, most of the responses of the teachers included the description of how the two knowledge systems are obtained, for example “observations”; and what each one was used for, such as “solutions to problems” or to “cure diseases”.

4.4.5 Teachers understanding of how scientific knowledge and indigenous knowledge are “bridged” in the classroom

In section B6 respondents were asked how they personally “bridged” the worlds of ‘scientific’ knowledge and ‘indigenous’ knowledge in the classroom. Table 4.16 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.16 Content words mentioned to describe how teachers ‘bridged’ scientific knowledge and indigenous knowledge in the classroom

Content word(s)	Frequency mentioned
Ask learners what they know	54
Accommodate both knowledge systems	46
Highlight the similarities	39
Discover prior knowledge and build on it	38
Explain scientifically from the book	18
Incorporate the content into the day to day life	14

- I would highlight the *similarities*, and how indigenous knowledge has been integrated into scientific knowledge.
- *Explain* that indigenous knowledge is *beliefs* and that it may not be right or wrong. Scientific knowledge is *proven* correct by experiments, etc.
- Give *respect* to *both* by mentioning them both. Do not treat indigenous knowledge with disdain.

As shown in Table 4.16, most of the responses of the teachers included the description that they would ask the learners what they know as well as to highlight the similarities between the two knowledge systems. In explaining how the two knowledge systems could be “bridged,” various examples were provided, for example, first explaining the indigenous knowledge of the learners, and then giving the scientific explanations.

4.4.6 Teachers understanding of the usefulness of the textbooks for implementing LO3 in the classroom

In question D3 the respondents were asked whether the currently available textbooks were useful in the implementation of Learning Outcome 3 in the classroom. Table 4.17 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.17 Content words mentioned to motivate whether the currently available textbooks were useful in the classroom in the classroom

Content word(s)	Frequency mentioned
YES, textbooks useful	
Covers both IKS and scientific knowledge	46
Deal with relevant environmental issues, such as global warming	36
Becoming more user friendly	24
Some have good case studies	18
Highlight connection between science, society and environment	17
NO, textbooks not useful	
Does not cover enough in-depth study	58
Learners don't identify examples in the textbook	48
Examples are superficial	39
Need to consult a few textbooks-very time consuming	32
Only case studies	25
Focus on beliefs of cultural groups	

- Some have good *case studies*, but learners are not very interested in indigenous knowledge systems.
- *Not all* the textbooks; you need to consult quite a few and it is time consuming.
- No- textbook authors don't really understand and tend to focus on "stories" that *cultural groups* believe.

As shown in Table 4.17, most of the responses of the teachers who motivated that the current available textbooks were useful included the description that the textbooks included both IKS and scientific knowledge, as well as that the textbooks dealt with relevant topics. However, those teachers who responded that the textbooks were not useful included that the textbooks do not cover enough in-depth studies as well as the fact that the learners were not familiar with the examples in the textbooks. This may be because IKS is local knowledge and learners in the Western Cape Province may not be familiar with indigenous knowledge of for example the Eastern Cape Province.

4.4.7 Problems teachers face in implementing the integration of scientific knowledge and indigenous knowledge in the classroom

In question D6 respondents were asked to explain what problems they faced in implementing the integration of scientific and indigenous knowledge. Table 4.18 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.18 Content words mentioned to explain the problems the teachers faced in implementing the integration of scientific and indigenous knowledge

Content word(s)	Frequency mentioned
Lack of training	
Lack of training	68
Lack of knowledge	45
No background knowledge	34
Getting learners to understand the connection between IKS and science	18
Background of different cultures lacking	13
Lack of resources	
Lack of resources	38
No time to research and include indigenous knowledge	25
Different information with regard to existing IKS	10
Resources are often one-sided	8
Learners	
Learners have lack of background knowledge	34
Learners completely unaware of the culture and views of others	30
Learners not keen to learn from other cultures	23
Narrow-minded learners	12
Multicultural plays a role	7

- Lack of background *knowledge* and lack of training.
- *Resources* are often one sided and therefore no comparisons.
- Many learners are completely unaware of the *culture* and views of others.

As shown in Table 4.18, most of the responses of the teachers could be grouped into three main themes. The first theme, namely lack of training, included responses such as no training, lack of background knowledge and no knowledge. The second theme, namely the lack of resources, included responses such as lack of resources and no time to research indigenous knowledge. The third theme, namely learners, included responses such as learners have no background knowledge and that learners were unaware of other cultures.

4.4.8 Assistance needed by teachers to implement LO3

In question D7 respondents were asked what assistance they needed in implementing Learning Outcome 3. Table 4.19 presents some of the content words mentioned by the teachers on the NOIKQ questionnaire. A small number of illustrative examples of the written comments are also included.

Table 4.19 Content words mentioned to describe what assistance teachers needed to implement LO3

Content word(s)	Frequency mentioned
Workshops	
How IKS material is developed and tested	36
Linking with other schools/ EMDCs, provinces	28
Hands-on training	25
Workshops and activity tasks	24
Saturday workshops	12
Workshops on LO3	11
How to deal with multicultural classes	10
Resources	
Examples of activities	46
Learning support material	45
Books, practical worksheets, questionnaires	35
Advisory assistance	
Assistance from a source from the department	18
How to implement core knowledge in relation to LO3	15

- More on *IKS examples* and how they are developed and tested.
- Hands on *training* during school holidays. Worked out examples of assessment tasks would be useful.
- *Workshops* and activity tasks. More content on IKS.
- Books/practical *worksheets* and questionnaires.

The aspects mentioned in the above-mentioned responses from the teachers will be discussed in detail in chapter 5.

PART B: Findings from the qualitative data

The second major step after the quantitative data collection and analysis entailed a small- scale qualitative study in the form of classroom observations, followed by teacher and learner interviews (Johnson & Onwuegbuzie, 2004). A quasi-experimental

design (as described in Chapter 3, page 84) was used in this research design. The major purposes of this small - scale design were to establish how effective the intervention in the form of the in-service-training workshop was, as well as to observe and understand the context of the implementation of the integration of science and indigenous knowledge in the classroom. Details of the workshop were presented in Chapter 3 (page 87). Eleven teachers were observed in their classroom. There were two experimental groups. The first group consisted of three teachers that were observed twice: once before they had training and again after they had training. The second experimental group consisted of two teachers who were only observed once, after they received the training. There were two control groups. The first control group consisted of three teachers who were observed twice. The second control group consisted of three teachers who were observed only once. The purpose of the two control groups as well as two experimental groups was to establish if there were any differences between the last observations of these two groups. Any differences could be attributed to a reactive effect of the pre-observation.

In analyzing the qualitative data, the researcher used a thematic approach, guided by the five-step model of Snively and Corsiglia (2001). The first stage in the analysis, the researcher developed a schedule for the level of integration of IK into science in the following manner: The five-step model for integrating science and indigenous knowledge of Snively and Corsiglia (2001) was used as themes to guide the search for common patterns of the classroom practices. Each step of the five-step model of Snively and Corsiglia (2001) was identified as a theme, namely step one, choose a topic or science concept; step two, identify personal knowledge; step three, research the various perspectives; step four, reflect; and step five, evaluate the process. From these five themes, 11 sub-themes were developed. Each of these 11 sub- themes was given a value of one to three, which served as an indicator of the link to the theme. For sub-theme one, a value one indicated no IK link to the chosen topic; a value two indicated a vague IK link to the chosen topic; and a value three indicated a clear IK link to the chosen topic. For sub-themes two to eleven, a value one indicated no opportunity with regard to the particular theme; a value two indicated limited opportunity with regard to

the particular theme; and a value three indicated extensive opportunities with regard to that particular theme. In the next step, the researcher used the video data, as well as notes from the classroom observation, to award the teacher a value between one and three to indicate the level of integration of IK into science. The reasons, from the video data, for awarding a particular value was used as evidence, and indicated on the schedule. In this manner the level of integration of IK into science for all 11 teachers were completed. Copies of the level of integration for each of the 11 teachers are reproduced in Appendix 13 (page 271). The scores attained for each sub-theme was represented visually by means of a graph. The researcher used a narrative format to describe the science lesson of each teacher. The section that follows will describe the classroom observations of the 11 teachers. It was indicated in Chapter 3 that pseudonyms will be used to protect the identity of the teachers as well as their schools. Thus, the names of the teachers used below are not their real names.

4.5 The first experimental group of teachers

Bet, Mikes and Thabisa formed the first group of experimental teachers. These teachers were observed twice. They were observed for the first time followed by an intervention where they received training on how to integrate indigenous knowledge and science. The three teachers were observed for a second time two weeks after the training.

4.5.1 Bet

Bet is a female teacher who completed her teacher training at a local university and has a B.Sc. (Ed.) academic qualification. She has been a teacher for 14 years, of which ten have been at her present school. On the day of the first classroom observation, the researcher met Bet in the principal's office. Bet then took the researcher to her laboratory classroom. The laboratory had tables and chairs, which were not grouped in the traditional rows facing the teacher.

When the period started, 40 chatting and laughing learners entered the classroom. The teacher introduced the researcher as well the senior audio-visual technician of the University of Cape Town, who filmed the classroom observation, to the class. When the lesson started, the teacher asked the learners to page to the activity on the reflex arc in their textbook. By means of the question and answer method the teacher revised the lesson of the previous day. After the initial question and answer session, the teacher proceeded with the particular lesson for the period.

During the introduction of the new lesson the teacher again skillfully used the question and answer method, while writing a summary of the lesson on the blackboard. The teacher explained the reflex arc to the learners. After explaining how the reflex arc functioned, she asked the learners if they had been to a medical doctor to have their reflexes tested. Then she demonstrated what a medical doctor would do if they had their reflexes tested. Thereafter she provided poster boards that the learners they had use to do an activity in groups.

After completion of the activity, the learners answered the questions. Each group had to report their answers to the rest of the class. The teacher then explained the answers to the rest of the class. After a brief discussion, the teacher asked the learners to work in their groups to answer the last question in the activity. This question referred to how they would feel if they were paralysed and how they would like other people to treat them. After five minutes of discussion amongst themselves in their groups, the learners reported their answers to the rest of the class. As the learners reported their answers, the teacher wrote a summary on the blackboard. During this discussion some values and ethics associated with the western scientific perspective were discussed. Some values, such as, for example, respect dignity and compassion was mentioned by the learners. For example, one learner mentioned “I would like people to treat me like a normal person and to treat me fairly and people not to discriminate against me. I would feel helpless and would not have a reason to live anymore.” The teacher then explained some misconceptions to the class, such as, for

example, one cannot expect to be treated equally. This resulted in a heated discussion among the learners. A few minutes later the lesson ended. The teacher partly summarized the lesson and asked the learners to complete the following activity for homework: “What can the school do to make life easier for learners in wheelchairs.”

The second classroom observation of Bet took place three weeks after the first observation, and after she had been trained on how to integrate science and indigenous knowledge (i.e., participated in the workshop).

The teacher introduced the researcher as well as the audiovisual technician to the class. The teacher divided the class into different groups. Each group was provided with a particular herb (wormwood). The teacher asked the learners whether they knew what the herb was and what it was used for. All the learners could identify the herb. Then the learners explained what the wormwood was used for and how they used the wormwood at home. When a learner mentioned that he added salt and garlic to the wormwood brew, the teacher was bewildered and enquired for what the purpose salt and garlic were added. The learner explained that the mixture relieves a sore throat.

The teacher gave the groups information to discuss. Each of the five groups was named as follows: the scientists, the botanists, the big corporations, the elders, and the people of the community. Each group represented either an indigenous perspective or a western scientific perspective, although this was not explicitly stated as such. Three groups, namely the elders, botanists as well as the people of the community gave the indigenous knowledge perspective. The scientist and the big corporation gave a western scientific perspective. The learners of the different groups discussed amongst themselves the perspective which was provided to them in writing. After the discussions, each group had to report to the rest of the class. The teacher wrote a summary on the blackboard while each group reported. The big corporations (i.e., the pharmaceutical companies) for example promised the scientist that would

market the herbal products worldwide. The scientists, on the other hand, were involved in researching the possible medicinal benefits of the plant. The elders were worried about exploitation of their people and the percentage profit that they would eventually receive. The people of the community on the other hand felt that they should also have a say in the development and marketing of the products. The botanists were concerned about the possible destruction of the natural habitat.

The teacher then allowed the different groups to discuss amongst themselves, what was summarized on the blackboard, viz. the main points that each group had suggested. This was followed by more group discussions. All the groups agreed that the community, the scientist, the botanist, and the elders of the community should benefit but not the big corporations. As the debate progressed the teacher noticed that there were disagreements amongst the groups. She allowed the groups to talk amongst them again. When the debate resumed, all the groups agreed that there should be a compromise. They came to an agreement that the plant belonged to everyone and that clinics must be built that would benefit everyone in the community. The lesson ended on a positive note. The teacher thanked the learners and told them that the debate would be continued the following day.

The classroom observations were analysed using the thematic approach. The scores attained for each theme were presented visually. Figure 4.1 presents a summary of Bet's scores for the two classroom observations.

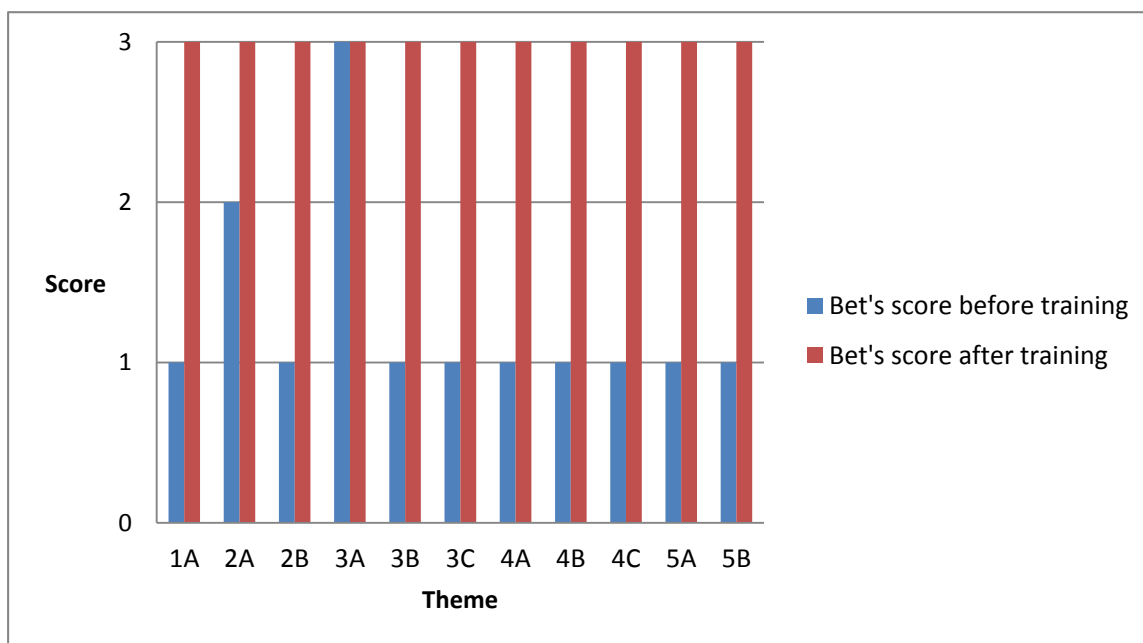


Figure 4.1 Visual summaries of Bet's scores for the classroom observations

4.5.2 Mikes

Mikes obtained his teaching certificate (HDE) at a local teachers training college, has 21 years teaching experience, and taught Natural Science in Grade 8 and 9 as well as Life Sciences in Grade 10 and 11. On the day of the first classroom observation the researcher met Mikes in the Principal's Office, and after some discussion followed him to his classroom.

When the lesson started, 40 talkative learners entered the classroom. The learners greeted the researcher as well as the teacher as they entered the classroom. The learners sat in traditional rows on chairs and tables facing the blackboard and the teacher. The researcher sat along the side of the classroom. The teacher introduced the researcher to the class and gave a brief background of the researcher to the class. The teacher then introduced the topic of the lesson, which was about medicines and their uses, to the learners. By means of the question and answer method the teacher established what the learners knew about the topic.

After the initial question and answer session the teacher proceeded with the new lesson. The teacher explained that if the learners were ill, their parents would take them to the medical doctor for treatment. These doctors obtained their knowledge from the westernized part, which is western scientific knowledge. The teacher explained that many years ago people did not go to the doctors but used herbs that would heal them. He mentioned that traditional healers were approached who used traditional herbs to treat illnesses. The teacher showed the learners various bottles of home remedies, for example Jamaica Ginger, *wit dulsies*, and *versterk druppels*. He explained to the learners what each of these home remedies were used for. Then the teacher referred to western medicines. He compared the two kinds of medicines and asked the learners if the one was better than the other. For example, if indigenous knowledge was better than western science or whether the two could work together.

The teacher divided the learners into groups. In the groups the learners discussed what indigenous knowledge and western science meant. They also had to give examples of these two perspectives. After the group discussions, the learners had to report to the rest of the class on what they understood about the two perspectives. The teacher explained the condition called AIDS after a discussion of the two perspectives reported was discussed. The teacher explained that the former minister of health, Dr. Msimang, said that if one uses certain herbs, for example African potato and garlic amongst other things one would be able to cure AIDS. However, antiviral drugs must also be used. Therefore the use of herbs, which was indigenous knowledge, and combining it with antiviral drugs, which was western science, one may live a few years longer. After completion of the lesson the teacher checked what the learners had written on their poster boards. There was also some evidence from the learners on their understanding of IK and western science. The teacher thanked the learners and asked them to complete their posters for homework after the siren wailed.

The second classroom observation of Mikes took place three weeks later, and after he had received training on how to integrate science and indigenous knowledge (i.e., participated in the workshop).

The teacher introduced the researcher to the learners. Thereafter, the topic of the lesson, which was “Medicines and their uses,” was introduced to the class. The teacher whispered a sentence to the learner in the front of the class and asked the learner to pass on the message to the rest of the class. After the message had reached the last person in the class, the teacher enquired what the message was. The teacher explained to the class that the exercise that they had just completed was the manner in which indigenous people passed on their knowledge. By means of the question and answer method the teacher sought information from the learners to find out from them what they knew about the topic. The teacher showed the learners various bottles of home remedies and explained to them what each one was used for. Then he explained to the learners that when they were sick they normally went to the doctor which was expensive. The learners were shown that a combination of local indigenous perspective with western science could be useful.

The teacher divided the learners into groups. The teacher gave the learners a questionnaire which had to be completed individually. Some of the questions referred to western scientific knowledge and examples of western science. After completion of the questionnaire the learners then had to report to the class. A class discussion followed after the report session. In the groups the learners discussed the indigenous knowledge perspective in a manner similar to that which the western scientific perspective was discussed. In other words the learners had to answer a questionnaire individually. After completion of the questionnaire, the learners had to report to the class. The class made comments in response to the report of the learners.

The learners compared the similarities and the differences between the two perspectives individually. They also had to mention two advantages and two

disadvantages of western science and indigenous knowledge. After the learners had completed the activity they had to report to the class. After reporting to the class, the learners gave commented on what had been reported by the class. During the discussion that followed the teacher provided the learners with a worksheet of a case study of Pakistan. In the case study it was shown that big pharmaceutical companies were over-exploiting the indigenous medicinal plants for money. This led to over-grazing, soil erosion, and deforestation. In the teacher's explanation about comparing the western science with the indigenous knowledge, a comparison was made of how expensive it was to go to the doctor compared to using local knowledge. Using local knowledge was much less expensive. Many learners did not believe the teacher about the use of the home remedies. The teacher showed the learners the jars of the medicines and asked some learners to read on the label on each jar to discover what the home remedy was used for. Many learners commented that they understood the local knowledge better and that they would use the local knowledge in future. The lesson ended and the teacher thanked the learners for their contribution. One of the learners then stood up and wished the researcher success in his studies.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.2 presents a summary of Mike's scores for the two classroom observations.

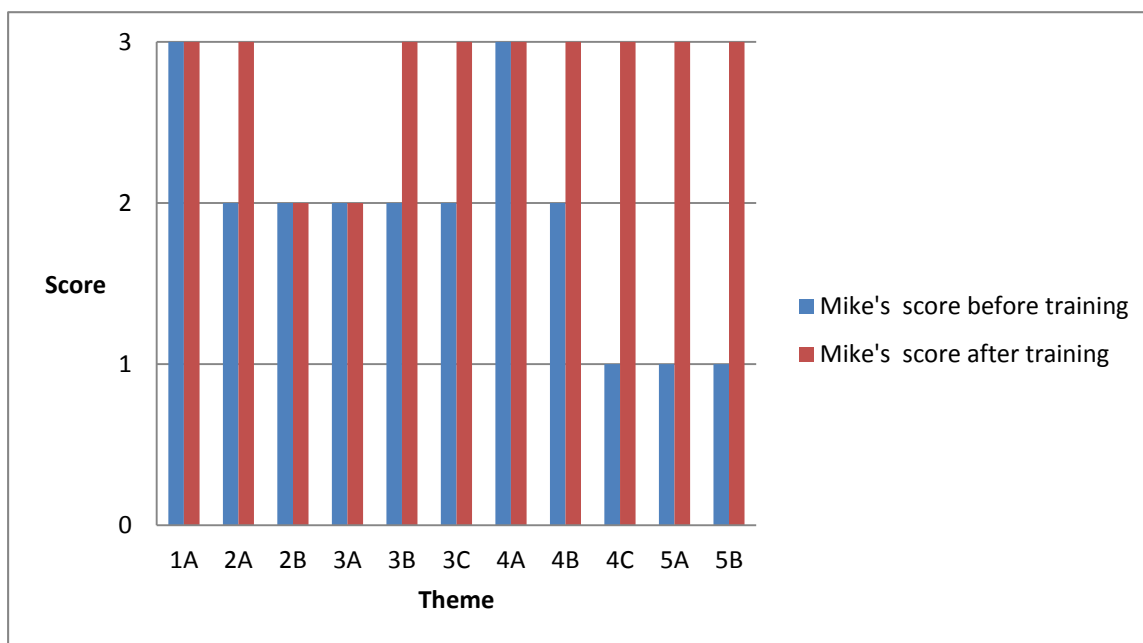


Figure 4.2 Visual summaries of Mike's scores for the classroom observations

4.5.3 Thabisa

Thabisa obtained her teaching certificate (HDE) at a local teachers training college and has six years teaching experience. She taught Life Sciences in Grade 10 and 11, as well as Mathematics in Grade 9. On the day of the first classroom observation, the researcher met Thabisa in the Deputy Principal's office. From there the researcher followed her to her classroom. The tables and chairs in the classroom were arranged in traditional rows, all facing the teacher and the blackboard. When the lesson started, 40 laughing and chatting learners entered the classroom.

The teacher introduced the researcher to the learners. Then the teacher introduced the topic of the lesson, "How African medicines were used to treat diseases" to the learners. The teacher started the lesson by asking the learners how cancer could be treated. There was a deadly silence and no learner attempted to answer the question. After some prompting from the teacher, the learners mentioned how cancer could be treated by radiotherapy, chemotherapy, surgery, as well as with plants such as *bucchu*

or the African Potato. The teacher asked a learner to identify an example of African medicine, the African potato.

After the introduction to the lesson, the teacher divided the class into groups. Each learner was provided with a worksheet. On this worksheet the learners had to explain what they understood by the term western scientific knowledge and indigenous knowledge. After a few minutes each group had to report on what they understood by the two terms. After all the groups had completed their report, a discussion followed. After the learners discussed the two perspectives in their groups, the teacher gave the learners examples of plants that were used as medicines, for example *Ikhala* (Aloe) and *Umhlonyane* (wormwood) and what condition each one was used. Then she asked the learners if they knew of any of their family members who used traditional medicine. One learner explained that her grandmother, who was a traditional healer, used a very special plant that healed cancer. At the end of the lesson the teacher asked the learners to complete an activity for homework.

The second observation of Thabisa took place three weeks later and after she had training on how to integrate science and indigenous knowledge.

The teacher introduced the researcher to the learners. Thereafter the teacher introduced the topic of the lesson, “Indigenous knowledge and its uses as a medicine” to the learners. A worksheet was given to the learners, who were seated in groups. In their groups the learners had to discuss what they understood by western scientific knowledge and indigenous knowledge. After a discussion amongst themselves, each group reported to the rest of the class. As the learners reported in their groups, the teacher wrote on the blackboard what was said by each group. A discussion then followed and the other groups could add to what was mentioned earlier.

After the group discussion about scientific knowledge and indigenous knowledge, the learners were provided with questions about how people have been using plants as medicines for thousands of years. The learners

had to answer the questions and report their answers to the class. All the learners answered the questions with regard to the medicinal uses of plants. They showed a good understanding of the different plants and could explain what the names of the plants were, as well as what they was used for. In each group a member had to provide an answer to a question. As the learners provided the answers, the teacher repeated the answer and asked the class members whether they agreed with the answer. In some cases the learners did not agree. The disagreements were discussed and cleared up. A discussion on the medicinal uses of plants followed. The roles of traditional healers were discussed, as well as the reasons why many patients, especially in the rural areas, visited traditional healers. Plants such as wild ginger have been traditionally used for the treatment of coughs and flu. It was explained that modern medicines, such as, Panado and Flutex are used today for colds and flu. The teacher explained how modern science and IK can both contribute towards curing coughs and flu.

The teacher asked the learners what the link between scientific knowledge and indigenous knowledge is. A discussion followed amongst the learners. Some learners provided answers which were disputed by other learners. For example, one learner said that there was no measurement in IK. Other learners said that that was incorrect and gave an explanation how measurement was done by their parents (which they considered as indigenous). Some learners expressed the opinion that “the modernized people do not use plants for medicine.” A heated argument followed and eventually consensus was reached that it was not so. During the group discussions, as well as the general classroom discussion, it became quite clear that the two perspectives were misunderstood. Many of the learners were of the opinion that there were many differences between IK and western science. They mentioned that with indigenous knowledge there was no testing but with Western science there was testing. It was also mentioned that people do not use plants as medicines. However, through discussion the learners had a clearer understanding of the two perspectives. The siren indicated the end of the lesson and the teacher asked the learners to complete a worksheet for homework.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.3 presents a summary of Thabisa's scores for the two classroom observations.

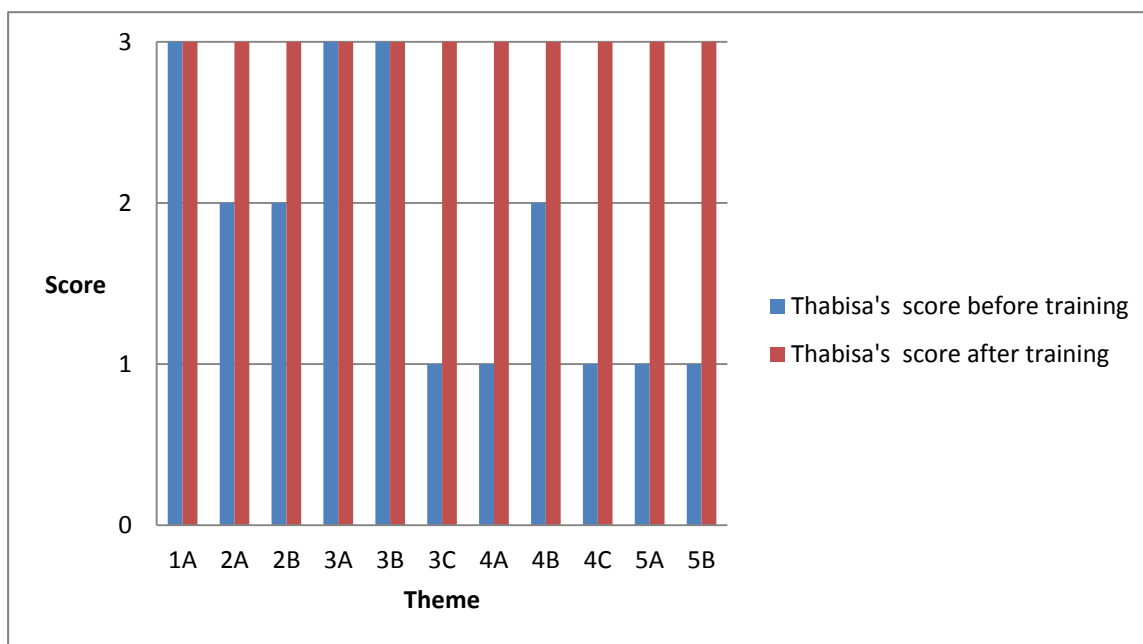


Figure 4.3 Visual summaries of Thabisa's scores for the classroom observations

4.6 The first control group of teachers

The three teachers Ursula, Manelli and Jonas formed the first control group and did not receive any training in the integration of scientific knowledge and indigenous knowledge. However, these teachers were observed twice, namely a first observation followed by a second observation two weeks later.

4.6.1 Ursula

Ursula is a female teacher. She has a BSc degree and a teaching diploma (HDE), and has taught for the past 16 years, of which 12 were at her present school.

The teacher and the researcher entered the classroom first. Thereafter the learners entered the classroom noisily. The teacher requested the learners to

be quiet and introduced the researcher to the learners. The learners sat in groups of eight, facing one another. The teacher introduced the topic of the lesson, “How biotic and abiotic factors were used in rituals” to the learners. After the teacher had explained the purpose of the lesson, the learners were asked to list all the biotic and abiotic components. While the learners listed the components, the teacher wrote down each component on the blackboard. After listing the factors, the teacher asked the learners to explain how the factors were used in rituals. The learners mentioned the different rituals, for example slaughtering of animals for weddings and funerals and water which was used to make African beer which was used for cleansing one from bad spirits. The teacher used the questioning technique to direct the learning; and the teacher in turn was guided by the responses of the learners. When the answer to a question was not what that the teacher wanted, she would guide the learners so that they could provide the answer she required. The learners, for example were asked how water was used in rituals. The learners provided different examples, which according to the teacher, were not the appropriate. The teacher said: “I thought about Moslems who also use water in rituals. We know that they pray a number of times a day, for example when they are fasting they have to pray five times a day. Every time before they go to pray they must also wash themselves, like after a funeral as you have said. They also have a ritual where they wash their hands, wash their mouth, and as they do that they pray.”

The learners mentioned that water was also used to in baptism. The teacher questioned the learners about baptism in their culture. The learners explained that baptism occurred by immersing into the water. It was evident that the learners knew the rituals in their culture. They mentioned quite a few, for example where the boys had to be initiated into manhood.

After a brief summary by the teacher, the learners were asked to write a page in which they had to describe how a particular natural resource was used in a ritual. Ten minutes after the teacher asked the learners to read their paragraphs which they had written to the class. The first learner read his paragraph which was about slaughtering of animals for initiation. The

teacher then explained to the rest of the class that they must firstly name the natural resource and then describe how it was used in the ritual. The teacher asked the second learner to read his paragraph. The learner responded by reading how plants were used to test if a girl was still a virgin. The lesson ended. The teacher thanked the class for their contributions and asked them to complete the essay given for homework.

The second classroom observation of Ursula took place three weeks after the first classroom observation. The teacher did not receive any training on how to integrate science and indigenous knowledge.

The teacher introduced the researcher to the learners. The teacher introduced the topic of the lesson, “Traditional healers,” to the learners. Using the question and answer method, the teacher asked the learners to give examples of medicinal plants. While the learners answered the questions, the teacher wrote their answers on the blackboard. At this stage many of the learners gave examples from their traditions, for example *ichala*, *mphepho*, and *mhloneyana*, which the teacher did not understand. However, she asked the learners to be more serious and not to play the fool.

After the discussion of medicinal plants, the teacher asked the learners whether they first went to the traditional healer, and when they were not cured, they had gone to the medical doctors. The teacher asked the learners what they knew about traditional healers. Most of the African learners are quite knowledgeable about traditional healers, an enthusiastic discussion followed. The teacher divided the class into five groups. In their groups the learners had to discuss the traditional healers. After ten minutes of discussions, each group had to report to the class. When the learners had reported after the group discussions, two of the groups mentioned that medical doctors used technology and can do tests which traditional healers cannot do. While the learners reported, the teacher wrote a summary on the blackboard. Two of the groups said that they preferred medical doctors and provided reasons for example doctors are professionally and technologically more advanced. The other three groups preferred traditional healers and

provided reasons for example they have psychic powers because they can look at you and immediately say what is wrong with you and that they were working with the ancestors.

The teacher informed the class that as a westerner she had learnt a lot during the lesson. She asked the learners whether their opinions on traditional healers had changed. All of the learners said that their opinion had not changed and that they still believed in the traditional healers. However, one learner said that it was best to believe in traditional healers as well as the medical doctors.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.4 presents a summary of Ursula's scores for the two classroom observations.

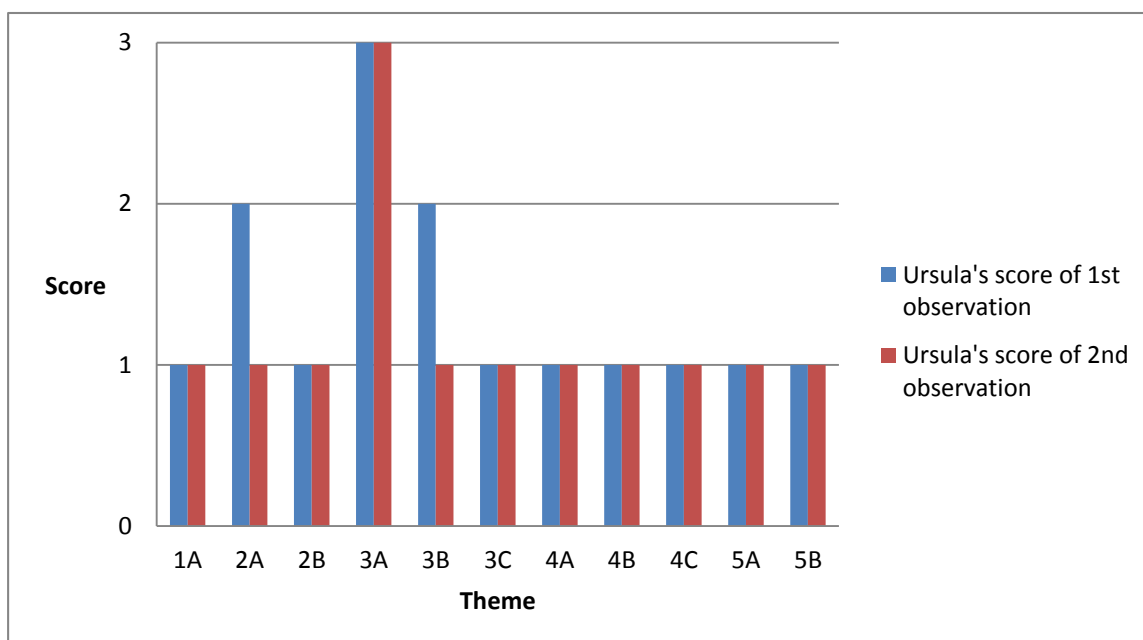


Figure 4.4 Visual summaries of Ursula's scores for the classroom observations

4.6.2 Manelli

Manelli is a young female teacher who completed her teacher qualification (B.Ed.) at a local university the previous year. This is her first year of teaching. The teacher did not receive any training on how to integrate science and indigenous knowledge.

The teacher introduced the researcher to the class. Thereafter the teacher introduced the topic, "The separation of substances" by explaining the aim of the lesson. By means of the question and answer method the teacher extracted information from the learners to discover what they knew about the topic, for example what a mixture was and how a mixture was formed. After the initial question and answer session, the teacher proceeded with the new lesson. The teacher explained the different methods used to separate mixtures. While the teacher explained the lesson, she wrote a summary of what was said on the blackboard. The teacher explained the first method of separation, namely hand sorting methods. She asked the learners to name which substances can be hand sorted. The teacher demonstrated this

method, using stones in a container from which the stones could be taken out of the container by hand.

The teacher proceeded with the second method of separation, namely the filtration method. The learners were asked to give examples of substances that can be separated by the filtration method. Some learners give examples which were not agreed upon by the rest of the class, for example fish oil and water. The teacher demonstrated the filtration method using the example of sand and water. The teacher went on to explain the third method of separation, namely, the magnetic method. After explaining this method, the teacher asked the learners for examples where this particular method could be used. The learners gave the example of iron fillings and sand, which are separated when the fillings are attracted to a magnet.

The teacher asked the class which mixtures could not be separated. There was no response from the learners and the teacher gave the example of yeast and flour. The teacher then went on to explain that homogenous mixtures could not be separated. The lesson ended when the teacher asked the learners whether there were any questions, but there was no response from the learners. The entire lesson was teacher-centered and the learners only listened as the teacher talked.

The second classroom observation of Manelli took place three weeks after the first observation. The teacher was not trained how to integrate science and indigenous knowledge in the classroom.

The teacher introduced the researcher to the learners. Thereafter she introduced the topic, “Biodiversity” to the learners. The lesson started with the teacher asking the learners what plants were used for. Different responses from the learners varied from providing oxygen to making furniture. The teacher asked the learners to provide examples of medicinal plants, as well as what they were used for. The learners provided examples like *umhlonyane* (wormwood), which was used for flu. Other learners mentioned *imphepo*, which was burned inside the house to drive away evil

spirits. While the learners provided the answers, the teachers wrote the answers on the blackboard.

The teacher explained to the learners that if they did not have money to go to the doctor, then they could use less expensive potions made from medicinal plants. After twenty minutes the teacher introduced the role of traditional healers and *sangomas*, who used medicinal plants. The teacher asked the learners whether they preferred medicines made by traditional healers or prescribed by medical doctors. The majority of the learners preferred medicine provided by traditional healers. Reasons given by the learners for choosing traditional medicines included that they contained no chemicals; the healer went to the veld to find and boil the plants. However, one learner mentioned that he preferred medicines provided by the medical doctor above those provided by the traditional healer. The reason why he preferred prescribed medicines of the medical doctor was that traditional healers had no medicines for AIDS. The rest of the class disputed this because he said there was no cure for AIDS. A discussion followed about why traditional healers were consulted mostly by people in rural areas. The learners mentioned that there were no clinics in rural areas and that people had to travel many kilometers to visit the medical doctors.

After fifteen minutes the teacher divided the learners into groups and provided them with a worksheet about traditional healers. The teacher explained to the learners that they had to discuss the questions on the worksheet, and that one learner from each group should report to the class. After ten minutes reports were made to the class. The first group answered their questions. The class made a noise and the teacher asked them to be quiet. The learners read out the answers. The teacher listened to the answers, but did not rectify the wrong answers. All the groups read their answers. There was no discussion after the report by the learners. The teacher thanked all the learners. The lesson ended.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.5 presents a summary of Manelli's scores for the two classroom observations.

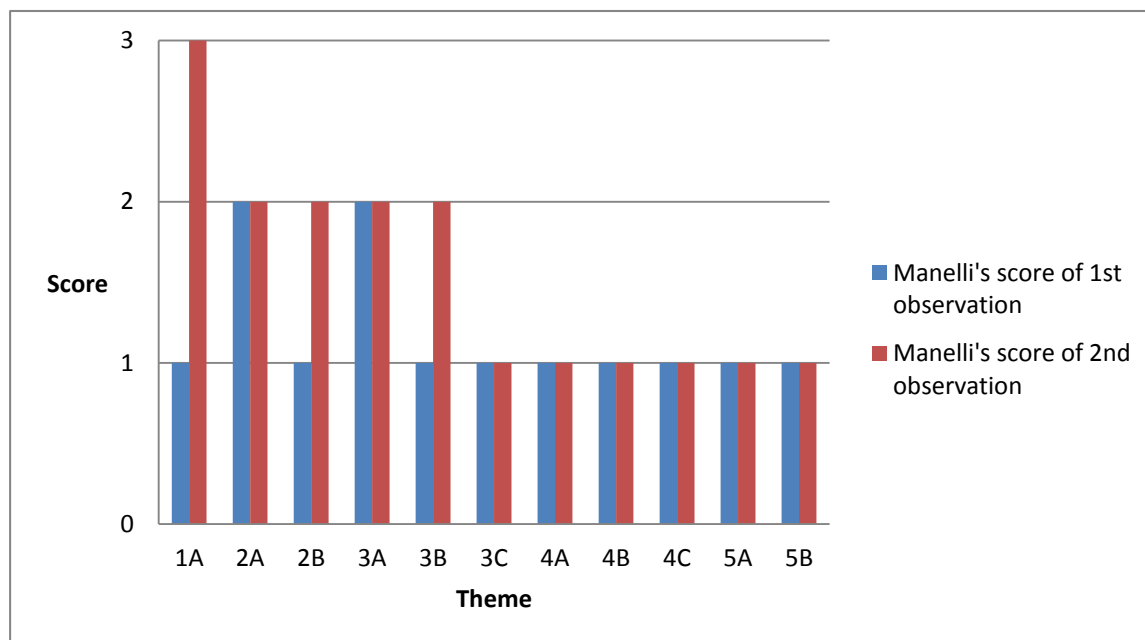


Figure 4.5 Visual summaries of Manelli's scores for the classroom observations

4.6.3 Jonas

Jonas is a female teacher who completed her teaching certificate (HDE) at a local teachers training college. She has nine years teaching experience. She taught Natural Science to Grade 9 learners, as well as Life Sciences to Grade 10 learners. The teacher did not receive any training on how to integrate science and indigenous knowledge. On the day of the first classroom observation, the researcher met Jonas in the Principal's office. From there the researcher followed Jonas to her classroom.

After the learners had entered the classroom, the teacher introduced the researcher to the learners. The teacher then introduced the topic of the lesson, "The carbon cycle" to the learners. By means of the question and answer method the teacher attempted to find out what the learners knew about the topic. The teacher asked was low-order questions, for example:

Name examples of natural substances; in which way they survived from trees; what the fresh air is called.

Ten minutes after the initial question and answer session, the teacher proceeded with the new lesson. Using a worksheet, the teacher explained the carbon cycle to the learners. The teacher mentioned that in her culture indigenous plants were used by *sangomas* to make medicines and therefore plants were very important in her culture. She asked the learners why a person should have a pot plant at home. The learners responded that whilst they were sleeping, the plants inside the home produce oxygen and take in carbon dioxide. While the learners answered the questions the teacher wrote a summary on the blackboard.

Fifteen minutes later, after the explanation of the carbon cycle, the teacher divided the class into groups. In their groups the learners had to discuss a worksheet. During the discussion of the worksheet the learners asked each other questions. After ten minutes of discussion the teacher asked the learners to report to the class. After each group had reported their answers the teacher would ask the class whether they agreed with the answers. Many of the learners were unclear about the answers that were provided by the class. The teacher explained the questions again, and the learners discussed their answers in more detail. The group reported to the class, and a discussion followed after each group had reported. At the end of the lesson the teacher told the learners that if they wanted to know more about the carbon cycle they should use the internet to obtain it.

The second classroom observation of Jonas took place three weeks after the first classroom observation. Jonas was not trained on how to integrate science and indigenous knowledge in the classroom.

The teacher introduced the researcher to the learners. Thereafter she introduced the topic of the lesson, “Light” to the learners. The teacher divided the class into seven groups. She supplied each group with a ruler, a glass beaker with water, and a clean sheet of paper to record their

observations. The teacher asked the learners to put the ruler into the glass beaker and to write down their observations. The teacher asked one person to record the observations, whilst the rest would discuss the observation. The teacher went around to all the groups to observe what they were doing.

After five minutes the teacher asked the groups to provide the answers to the class. The first group provided its answer, which was that the ruler appeared to be bigger when it was in the water. The teacher wrote the answer on the blackboard. The second and third group provided a similar answer. Another group said that the ruler did not have the same shape. The teacher explained the bigger shape of the ruler and how the water bent the ruler. The teacher asked the learners to draw a labeled drawing of how the apparent bending took place. The teacher went around to the different groups to assist the learners whilst they were completing their drawings. After a few minutes the teacher completed the drawing on the blackboard. After she had completed the drawing, the teacher then explained the drawing, talking about the incident and refracted image.

Five minutes later the teacher asked each group to put a coin into the water, and to observe the image of the coin and to write down their observations. After five minutes the teacher asked the different groups to report their observations to the class. The first group reported that the coin was getting bigger and that the water rose. The teacher asked the groups if there were any answers that were different from that of the first group. The second group said that they observed two coins. The third group said that that the coin became bigger but from the top it looked smaller. The teacher explained the observations of the learners by explaining that it was the water which changed the shape of the ruler as well as of the coin. The teacher continued to explain the role of water as a natural resource. The teacher said that the class had experimented like scientists do. At the end of the lesson the teacher thanked the learners, and asked the learners to complete their drawings for homework.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.6 presents a summary of Jona's scores for the two classroom observations.

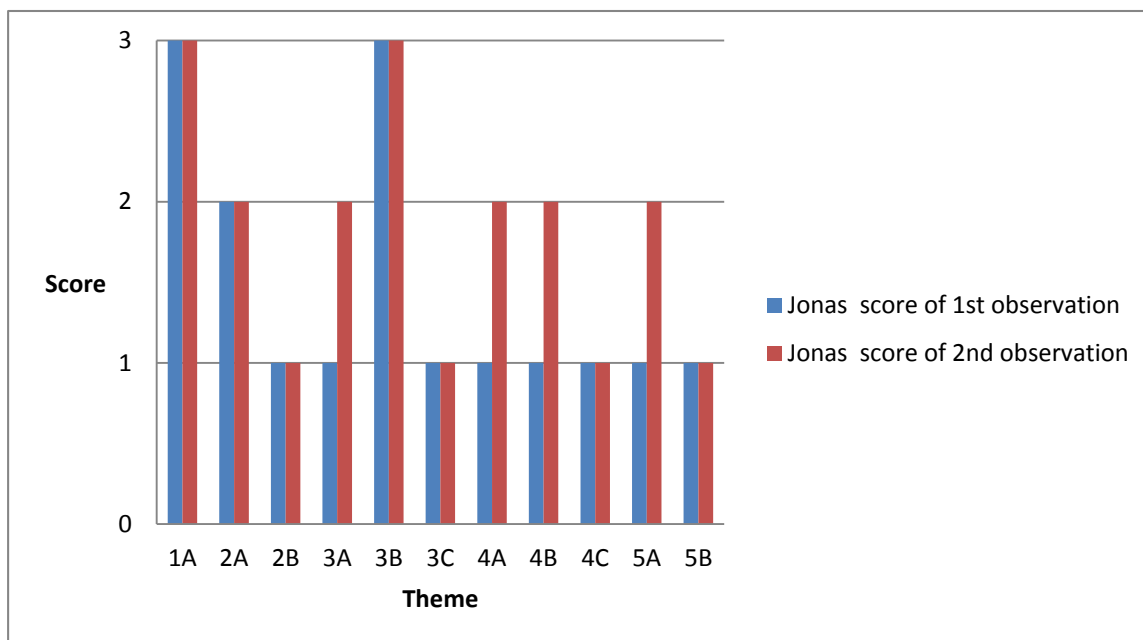


Figure 4.6 Visual summaries of Jona's scores for the classroom observations

4.7 The second control group of teachers

Bradley, Wayne, and Sutwana formed the second control group. This group was not trained in the integration of indigenous knowledge and science, and was observed only once.

4.7.1 Bradley

Bradley is a male teacher, and has a BSc science degree and a teaching diploma (HDE) and has been teaching for the past fifteen years. The teacher did not receive any training on how to integrate science and indigenous knowledge.

The teacher introduced the researcher to the learners. The teacher introduced the topic and asked the learners to open their notebooks and to

read their notes. He asked the learners questions about the structure of the eye as well as the functions of the eye, for example why the pupil became bigger and smaller. All the learners responded. By means of the question and answer method the teacher attempted to find out what was known about the topic. An activity of the eye was then shown on the board. The teacher asked one learner to complete the activity on the board by labeling the structure of the eye. By means of the question and answer method the teacher explained the structure as well as the function of the eye (e.g., pupil mechanism).

The teacher then distributed an activity on the eye, from a grade 12 question paper, among learners, and asked them to answer it individually. The teacher gave the learners four minutes to complete the activity. After four minutes the teacher asked the learners to answer the questions. One learner provided an answer, which was disputed by the other learners. With the assistance of the teacher, and by discussion amongst the learners, the right answer was derived at. After the completion of the activity, the teacher introduced the concept of indigenous knowledge to the learners. By means of the question and answer method, the teacher established what was known about the topic. The teacher divided the class into six groups. In the groups the learners had to discuss home remedies that could be used for the treatment of two diseases of the eye, namely, sty and conjunctivitis. Each group provided examples of home remedies, for example, tea bags for conjunctivitis and a nappy that a baby had urinated on for sty. After a discussion the teacher asked the learners if they knew of other remedies but there was no response from the learners. The teacher said that he did not use the home remedies because he went to the medical doctors. The teacher provided examples, which he found on the internet, to the class.

The teacher gave an activity about protecting the indigenous knowledge systems and projects to protect medicinal plants. The teacher asked the learners to complete the activity in groups. After ten minutes the teacher asked the learners to answer the questions. The first question dealt with sustainability. The first two groups provided their answers, and a discussion

followed. The teacher provided the answer, and asked the learners to write it down. The teacher asked the learners to provide examples of over exploitation in South Africa. The learners provided the examples, and the teacher as well as the class, discussed the answers. The teacher explained how abalone was over-exploited. Then teacher then mentioned how Hoodia was exploited. The teacher also explained how traditional healers and *sangomas* exploited the environment. The lesson ended. The teacher asked the learners to study their work because they would be writing their final examinations in due course.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.7 presents a summary of Bradley's score for the classroom observation.

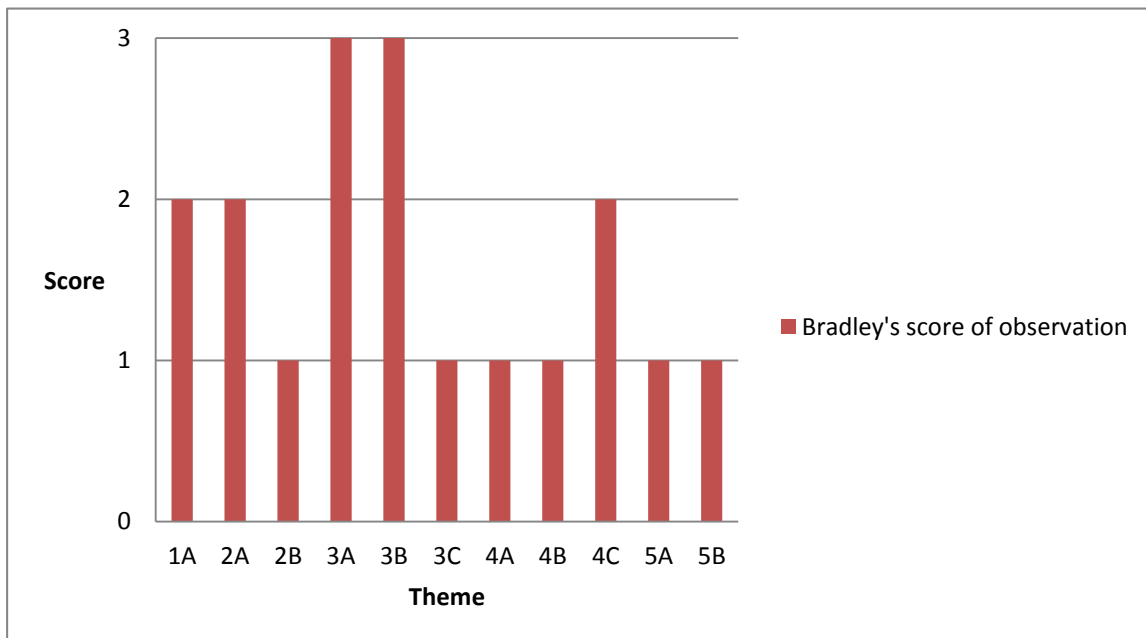


Figure 4.7 Visual summaries of Bradley's scores for the classroom observation

4.7.2 Sutwana

Sutwana is a female teacher. She has a BSc science degree and teaching diploma (HDE) from a local university. She has been teaching for three years, including one year at her present school. The teacher did not receive any training on how to integrate science and indigenous knowledge.

The teacher introduced the topic of the lesson, “Waves” to the learners. By means of the question and answer method the teacher sought information from the learners to discover what they knew about the topic. The teacher asked the learners what waves were and they responded by giving characteristics of waves for example, amplitude, frequency, speed, peak, etc. While the learners responded, the teacher wrote their answers on the blackboard.. After five minutes of this question and answer session, the teacher again asked the original question, “What is a wave?” A learner responded and the teacher wrote the answer on the blackboard.

After the introduction, the teacher proceeded with the lesson of the day. During the explanation of the new lesson, the teacher used the question and answer method, and writing a summary on the blackboard. The teacher talked about the motion of waves, for example longitudinal and transverse. She asked the learners to explain the concept of longitudinal movement, and a learner gave an explanation. The teacher demonstrated how waves were formed and compressed. The teacher asked the learners for examples of transverse motions of waves as well as what a wavelength was. After several learners had provided answers, the teacher wrote down the definition of a wave on the blackboard. The teacher then asked a learner what frequency was. The learner responded and was enthusiastically applauded by the rest of the class.

The teacher called two learners to the blackboard to identify the wavelength drawn on the blackboard by the teacher. The first learner labeled it incorrectly and the second learner corrected the first one. The teacher called up another learner to label the frequency of the wave on the blackboard.

After the learner had completed it, the teacher asked the learners whether it was correct. The learners were unsure. The teacher asked another learner to label amplitude on the blackboard. The teacher explained the characteristic of the wave to the learners. A different learner indicated the peak of the wave on the blackboard. The teacher explained that if a wave is shown, then all of the characteristics must be indicated. The teacher explained by means of formulas how the speed and velocity of the waves could be calculated. The teacher explained how units were used and wrote an example on the blackboard. She asked the learners to complete the examples in their notebook. The learners completed the example individually. The teacher moved through the class and assisted the learners.

After ten minutes, four learners were asked to complete the examples on the blackboard. After the learners had completed the examples, the teacher asked the rest of the class whether the examples that had been completed on the blackboard were correct. Again the class was unsure. The teacher wrote another example on the blackboard and asked the learners to complete it. The learners completed the example and the teacher went through the class and marked the worked out examples of the learners, and assisted where possible. The teacher explained the answers to the class. At the end of the lesson she asked the learners to complete some more examples for homework.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.8 presents a summary Sutwana's score for the classroom observation.

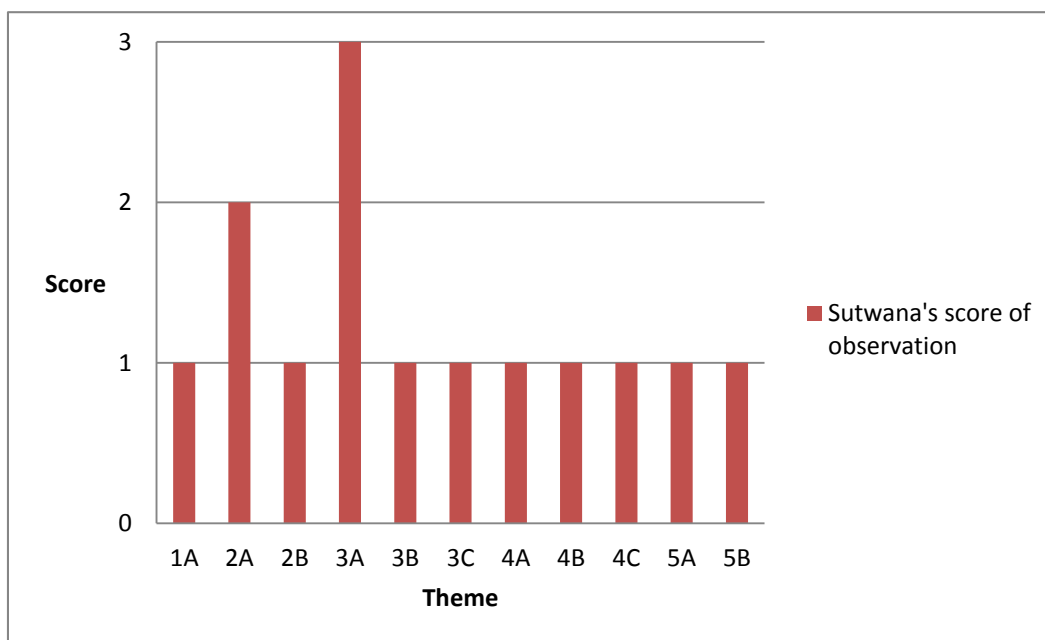


Figure 4.8 Visual summaries of Sutwana's scores for the classroom observation

4.7.3 Wayne

Wayne is a male teacher who obtained his teaching qualification (HDE) at a local teacher training college. He taught for 23 years, including 15 at the present school. The teacher did not receive any training on how to integrate science and indigenous knowledge. Before the lesson started, the researcher and the teacher waited in the classroom for the learners to arrive. A few minutes later, 43 learners entered the classroom noisily.

The teacher asked the learners to be quiet and to sit down. The teacher introduced the researcher to the learners. Thereafter the teacher introduced the topic of the lesson, "Nutrition in plants" to the learners. By means of the question and answer method the teacher skillfully sought information from the learners by asking them what they knew about the topic. The teacher showed a jar with cloves in it to the learners. The teacher then gave a few jars with different spices in them to the learners to look at. By means of the question and answer method the teacher illustrated how all the herbs and spices came from plants. The teacher referred to the jar with cloves again,

and asked the learners what the cloves could be used for. Some learners mentioned that it could be used in the preparation of food. One learner mentioned that one could use the clove when one had toothache, which would cause the pain to disappear. Another learner mentioned that the cloves could also be used to keep the flies away. The whole class laughed and the teacher asked them to be quiet and to give the learner an opportunity to explain why he said so. The learner explained that the cloves must be placed inside an orange, which would keep the flies away.

The teacher asked the learners how a plant eats (*sic*). The teacher switched on the overhead projector to show a transparency. After an explanation of van Helmond's experiment, the teacher showed a drawing of a plant on the screen. By means of the question and answer method the teacher completed the picture on the screen. He asked the learners low-order questions, for example "What does the tree exhale; what do humans inhale," etc., and while they responded he wrote the answers on the transparency. The teacher showed the learners van Helmond's experiment in the textbook. The teacher explained that another scientist, namely Priestly took van Helmond's experiment further and found that plants also needed oxygen and carbon dioxide in order for them to live. The teacher handed out a worksheet to the learners. He asked the learners to use the worksheet and to copy down the notes from the transparency. They had to write down the names of oxygen and carbon dioxide, as well as their symbols on the paper and to put the worksheet in their notebooks.

The teacher then showed the learners a packet of wormwood. He asked a learner what wormwood was used for. Four learners named the functions of wormwood, for example to use it if your stomach cramps. The teacher asked the learners how they knew that the wormwood could be used to treat many different illnesses. The learners said that their parents and grandparents told them. The learners then spoke about Rastafarians who go into the mountain to fetch plants. The teacher explained that the knowledge was passed on orally from their grandparents to their parents and their parents passed the knowledge on to them. The knowledge is now getting lost because their

parents did not tell them everything, and that many grandparents are now dead with their knowledge. The teacher went on to explain that sometimes the knowledge can be passed on inaccurately. The teacher went on to explain that the home remedies that the parents pass on are not in recorded textbooks, and that is why it could be passed on inaccurately.

The teacher then put on a transparency which showed how the plant manufactured its food. The teacher explained that the tree manufactured food on the way depicted on the transparency. He asked the learners how their parents made food about ninety years ago when there was no electricity. A learner responded that they had to make fires. The teacher then asked the learners to discuss amongst themselves the food the people made in those days. By means of the question and answer method the learners mentioned the various kinds of food that their parents made, which had to come mostly from nature. By means of the question and answer method the teacher explained the cycle where the plants take in nutrients; plants that is being eaten by the animals, who defecates; and the nutrients that went back into the soil to be taken in by the plants again.

The teacher explained about our grandparents who passed on their knowledge orally, and they had died with their knowledge. The teacher informed the learners that they were told that cancer was incurable. Perhaps some of their grandparents had a cure for cancer. The teacher explained that amongst people in Africa there was a belief that there was a herb which could cure cancer. The teacher explained that chemotherapy could be used for cancer, but why should one suffer the disadvantages of chemotherapy when there was a plant which could heal you. The teacher explained to the learners that people are building more houses, and that they were removing all the trees, which resulted in less oxygen being available. The teacher asked the learners to complete for homework what they had learnt during the lesson. The lesson ended.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.9 presents a summary Wayne's score for the classroom observation.

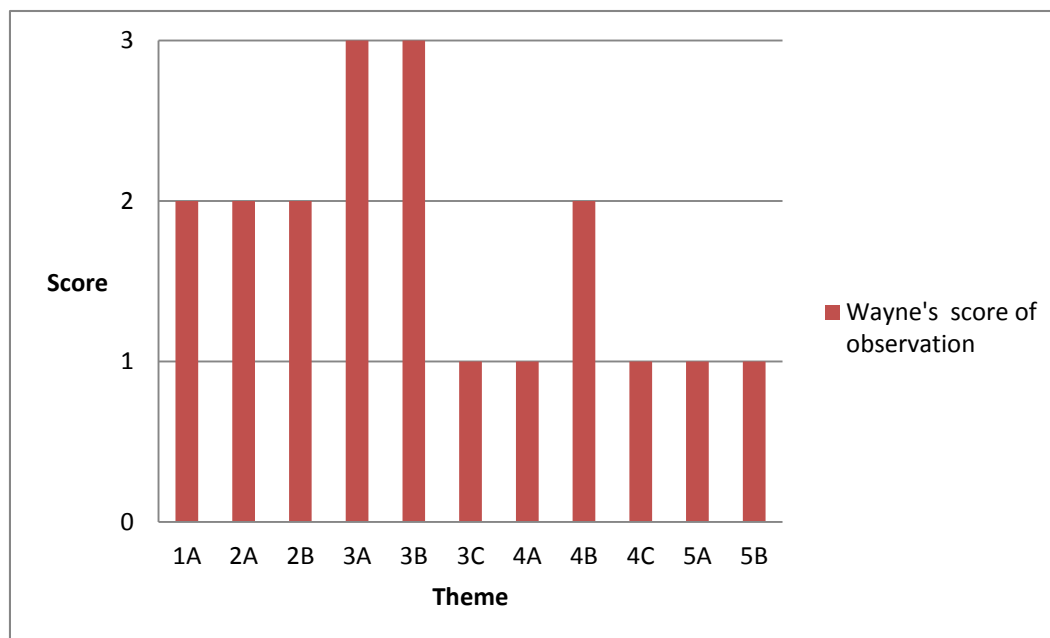


Figure 4.9 Visual summaries of Wayne's scores for the classroom observation

4.8 The second group of experimental teachers

Charles and Gareth formed the second experimental group. The teachers of this group were trained with the teachers of the first experimental group in the integration of indigenous knowledge and science. However, this group was observed only once. The classroom observation of this group took place two weeks after they were trained.

4.8.1 Charles

Charles is a male teacher, with a B.Sc. qualification, and has been teaching for 15 years, including nine years at his present school. He taught Natural Science to Grade 9 learners, as well as Life Science to the Grade 10 and 11 learners. The classroom observation of Charles took place two weeks after he had had training methods to integrate science and indigenous knowledge.

The teacher introduced the researcher to the learners. Thereafter the teacher introduced the topic of the lesson, “Indigenous knowledge and medicinal plants,” to the learners. The teacher asked questions to the class in general. He asked the class what they understood by the term indigenous. Two learners out of a class of twenty four learners responded incorrectly. The teacher read a few definitions to the class of what the term ‘indigenous’ meant.

The teacher divided the class into six groups of four learners each. In their groups the learners had to identify at least three indigenous plants; name three widely used medicines which were derived from the plants; what ailments the medicines cured; and finally to explain why the conservation of the natural habitat was important. The teacher showed the learners that the instruction he required them do was written on the blackboard. The learners had a group discussion whilst completing the task. There were quite a lot of misunderstanding as well as misconceptions among the learners as they answered the questions. For example, one learner in a group said that they must write down mint, which is used to spice food. The other learners commented that the teacher said that the plants must be indigenous. Another learner asked what ‘indigenous’ meant. The learners all worked actively in their groups, discussing the various remedies derived from plants. The discussion sometimes becomes quite noisy as some learners were not aware of the uses of the plants mentioned by learners in their group. The teacher assisted the learners and clarified where there were uncertainties.

After twenty minutes of discussion in groups, the teacher asked each group to report its answers, to name three indigenous South African plants that were used with economic success, to the rest of the class. The first group mentioned Hoodia which suppresses one’s appetite. The second group used *Eucalyptus* as their example. The teacher asked if the plant was indigenous. The learners were not sure. There were a number of discussions amongst the learners. The learners came to the agreement that it was indigenous. The third group gave *rooibos* as their example and gave the use of the *rooibos*. The teacher told the learners that the plants that they had mentioned were

used for different purposes. The teacher asked the learners to mention three widely- used medicines that were derived from the plants as well as the ailments they cured. The learners mentioned the different medicines as well as the ailments they cured. While the learners mentioned their answers, the teacher wrote their answers on the blackboard. A bell rang, indicating the end of the period. The learners got up to leave as the teacher tried to finish the lesson. The teacher mentioned that all the indigenous plants had a special role which they played and that their habitat should be conserved.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme was presented visually. Figure 4.10 presents a summary Charles' score for the classroom observation.

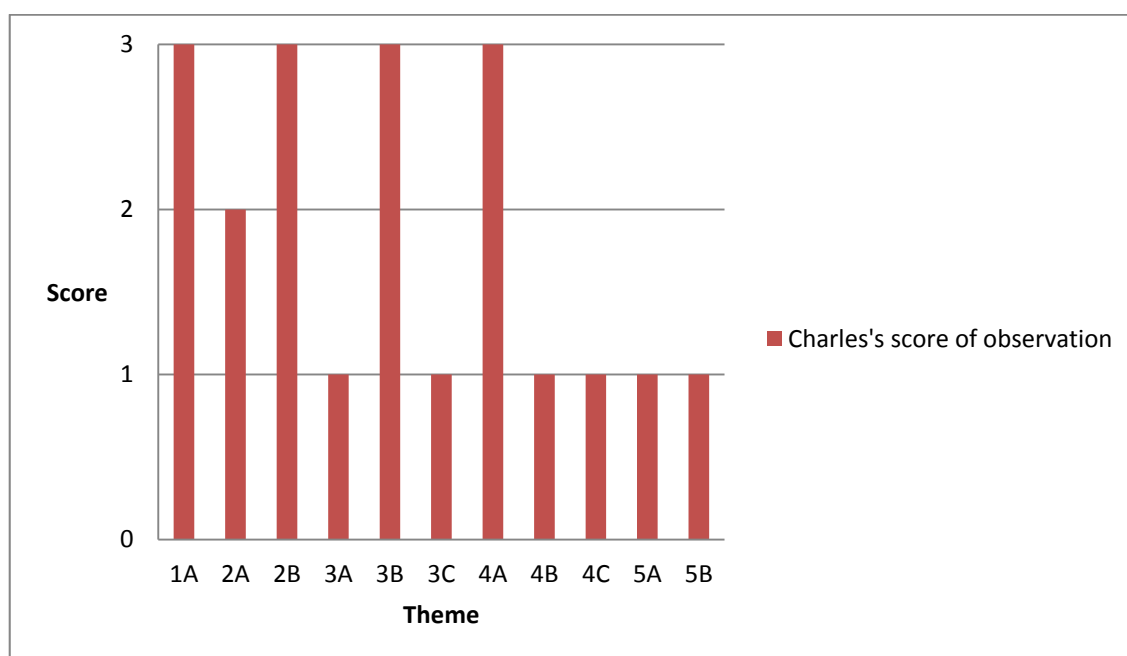


Figure 4.10 Visual summaries of Charles's scores for the classroom observation

4.8.2 Gareth

Gareth is a male teacher with a B.Ed. teaching qualification, and three years teaching experience. He taught Life Science to Grade 10 and 11, as well as Natural Science to the Grade 9 learners. The classroom observation of the teacher took place two weeks

after he had had training methods in integrating science and indigenous knowledge. On the day of the classroom observation the researcher met the teacher in the principal's office and from there followed him to his classroom.

When the learners entered the class, the teacher was still struggling to set up the data projector. Eventually the teacher was ready and introduced the researcher to the learners. The teacher then introduced the topic of the lesson, "Biodiversity," to the learners. By means of the question and answer method the teacher revised what is known about the topic. The teacher asked questions to the class in general. After the initial question and answer session to revise the previous day's work, the teacher proceeded with the new lesson. The teacher asked the learners the question, "What is biodiversity?" The teacher showed the correct answer on the screen.

The teacher went on to explain the answer, and asked another question which was put on the screen, "How does the biological resources make a contribution to the well-being of humans?" There were no responses from the learners, and the teacher showed the answer on the screen. The teacher explained that the plants and animals must be taken care of and preserved it for future generations. The teacher then explained about the Hoodia plant which was used by the San people as an appetite suppressant. The teacher showed a picture of the Hoodia plant on the screen. The teacher explained how the San people also used the Hoodia plant as a thirst quencher to sustain them for days while hunting. However, Hoodia was much more than an appetite suppressor and was used to treat various illnesses, such as abdominal pain, TB, and diabetes. The teacher then explained how Pfizer, the international pharmaceutical giant, began to work on the appetite suppressant qualities from the Hoodia plant. The teacher explained how the big pharmaceutical corporations for example Pfizer exploited the Hoodia plant and benefited from this plant financially. The San people seemed happy just knowing that the modern world had recognized that there was wealth in ancient knowledge, and that at least one tradition in there dying culture might be saved. The teacher showed the following quotation from Petrus Valbooi, a San leader, on the screen: "I do not think that we are being

robbed of our knowledge. I think that people who know how to live from the earth should share.”

After twenty minutes of explanations, the teacher asked the learners to complete an activity. Before the learners started on the activity, the teacher showed the learners a video clip. This video clip was a report that was published in Japan about the Hoodia plant, and showed how the plant was cultivated, how the active ingredient was extracted, and showed how celebrities like Nicole Smith benefited from the use of the tablets. The teacher showed the video clip and gave a commentary of the clip because the computer did not have a sound card. The teacher asked the learners to complete the question he gave them; to name only one person who could benefit from the Hoodia; and what must be done to preserve the Hoodia. The learners had to answer the questions individually, and wrote their answers in their notebooks.

The learners answered the questions individually and the teacher talked to the learners who required his assistance. After ten minutes the teacher asked the learners to give their answers to the class. The different answers the learners provided for the first question included: those people who are overweight; those people who were in training; the models; and the San people. The teacher asked the answers for the second question, about what must be done to preserve the Hoodia. Some of the answers the learners provided included: people should only be allowed to take a certain amount of plants out; people should have a permit and that they had to pay per plant and the proceeds must go to the San people. A discussion followed after the learners answered the questions. When the learners were answering the questions, the teacher noted that in all the cases the learners were only interested in the financial aspect and how a profit could be made. The teacher highlighted the fact that mankind is only concerned with making money and that they forgot about the wealth of our biodiversity for future generations. To illustrate this fact the teacher showed the following equation from the Cree Indian Philosophy on the screen: “Only after the last tree has been cut down, only after the last river has been poisoned, only after the last

fish has been caught, only then will you find out that money cannot be eaten.” The lesson ended and the teacher thanked the learners for their contributions.

The classroom observations were analysed using the thematic approach. The scores obtained for each theme were presented visually. Figure 4.11 presents a summary of Gareth’s score for the classroom observation.

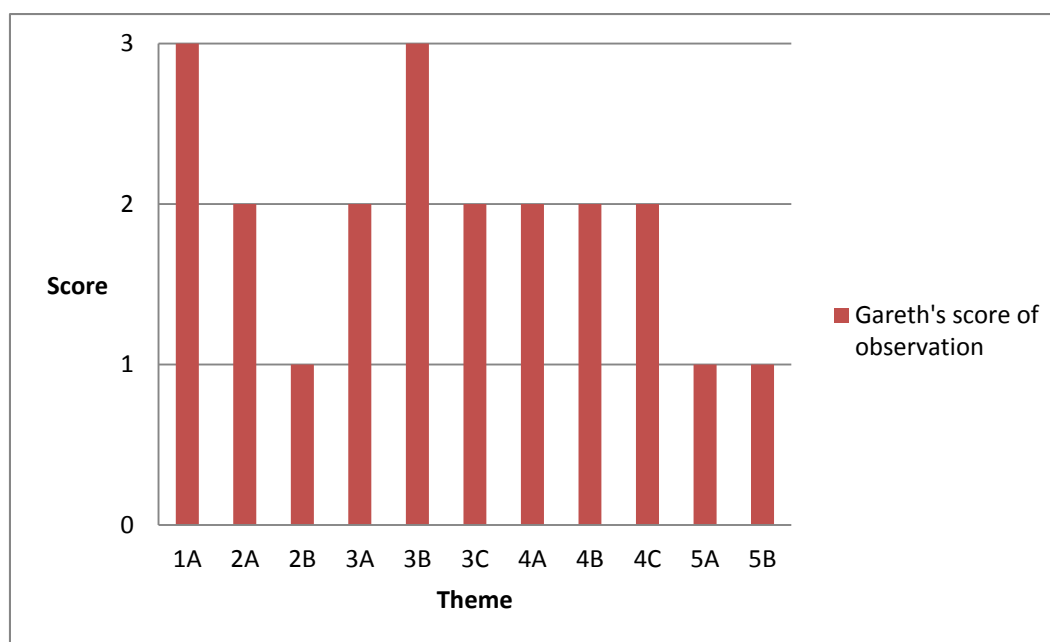


Figure 4.11 Visual summaries of Gareth’s scores for the classroom observations

The results of these classroom observations will be discussed in Chapter 5.

4.9 The interviews

Three teachers, namely, Bet, Mikes, and Thabisa, were interviewed two weeks after the second classroom observation.

One of the questions that the researcher asked all three teachers was: The new curriculum states that indigenous knowledge should be included in the curriculum. Is it possible to adhere to this statement and what problems may you encounter? Mikes

agreed that indigenous knowledge should be included. However, he had a problem with the local knowledge of the learner. Bet also agree, but foresees problems with National examinations because the indigenous knowledge of the Western Cape may not be applicable to for example in Kwazulu Natal. Thabisa also agreed that IK should be included in the curriculum. She compared the rural areas where people can go to the field to get plants to heal people, but in urban areas people have a problem because there it is said that the indigenous people are destroying the environment.

The teachers were also asked if they would use the kind of activities that they were exposed to in the workshop for future lessons. The teachers agreed that the activities were useful and used some of the activities in the observed lessons. Bet mentioned that the learners found the activity that she used in the observed lesson, interesting.

Another question that was posed to the three teachers was whether other teachers should also be trained in the integration of scientific and indigenous knowledge. All three teachers agreed that all teachers should be trained. According to Bet, if teachers are given some support material to start with then they could work from there. Mikes also agreed that all teachers should be trained. However, he had some misgivings because teachers always complained that they had a lot of administrative work and that they did not always have the energy to attend workshops.

Three learners from Thabisa and three learners from Mike's classes were interviewed two weeks after their observed lesson. They were asked whether the lesson that was videotaped was different to the way that their teacher normally taught. All the learners of Thabisa mentioned that the lesson was not different but when they were working in groups and sharing their views they were surprised by their classmates' knowledge of IK. The learners from Mike's classes said that their teacher taught the same way that he normally taught them and that there was nothing different. Thabisa's learners, who were all Xhosa-speaking, knew what indigenous knowledge was because their parents used indigenous knowledge at home. According to these learners they were interested in scientific knowledge because they were at school now. All the learners were asked

which way they preferred their teacher to teach, namely to find out what they knew about the topic first, and then proceeding with the lesson or to start immediately with the new topic. All the learners preferred the method where the teacher asked them questions about what they knew about the topic. The reasons provided by the learners included that they can take in what other people knew and then start with the new lesson to add more information to the known information.

4.10 Summary

This chapter reported the results of the quantitative data from 349 science teachers in eighty high schools. The quantitative response responses supported the hypotheses, namely those teachers who tend to score high marks in one section of the question will tend to score high marks in all other section of the questions.

The study found statistically significant associations between *population groups* and the teachers view on ‘scientific knowledge’; what distinguished ‘scientific knowledge’ from ‘indigenous knowledge’; and how they personally ‘bridged’ the two worlds of ‘scientific knowledge’ and ‘indigenous knowledge’ in the classroom. There were also significant associations between the *qualifications of the teachers* and their view of ‘indigenous knowledge’. Statistically significant associations between *language of the teachers* and what ‘indigenous knowledge’ and ‘scientific knowledge’ had in common were found.

The study also found that the teachers perceived “starting the lessons with the learners’ ideas before presenting the scientific view” as the most important strategy in achieving the science/ indigenous knowledge integration. The study also found that the teachers had a general lack of ‘scientific knowledge’ as well as ‘indigenous knowledge’.

Qualitative data was collected to elaborate on the quantitative results, as well as to triangulate the quantitative results, in order to produce valid and trustworthy results. The qualitative data was collected using classroom observations as well as interviews

with teachers and learners. Qualitative data was collected from eleven teachers from different schools. Five of the eleven teachers were trained in methods/ strategies to integrate science and indigenous knowledge in their classrooms.

Generally, the teachers attempted the participation of the learners constantly throughout the lesson presentations through effective questioning, or by requesting that the learners explain and predict events as they unfolded. In all cases the blackboard was used to reflect a summary of the lesson. Most of the lessons were also learner-centered, while few tended to be teacher-centered. The study found that when the classroom observations were analysed using the thematic approach, those teachers who had had training in strategies in the integration of science and indigenous knowledge, obtained higher scores after the training than those who did not have any training who received low scores before and after the training.

The results will now be discussed in Chapter 5.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter the findings of the study on the implementation of the integration of scientific knowledge and indigenous knowledge by science teachers in the Western Cape Province are discussed. Firstly, the rationale for this study is highlighted and the research question is stated in order to place the study in context. Secondly, the research design of the study is summarized and the limitations of the study are considered to allow an appropriate discussion of the findings. Thirdly, the research questions are answered. Finally, the significance of the study is discussed and recommendations are made for classroom practice, professional teacher development programmes, and education policy makers.

The present study was conducted to describe, analyse, and compare whether the integration of scientific knowledge and indigenous knowledge, as expected by current curricular reforms is being implemented by high school teachers in selected school settings in the Western Cape Province of South Africa. Until 1994 the apartheid government provided separate, racially divided education systems which were unequally funded. The apartheid education system was characterised by racial division aimed at preparing South Africans for the Apartheid labour market, and a curriculum which encourages knowledge transmission and rote learning (Kallaway, 1984). Education for Whites was compulsory, free, and better endowed with state funding. Black education on the other hand suffered from the consequences of insufficient provision, insufficient funds, curriculum deficiencies and inadequate teacher training, as well as overworked, underpaid, and unmotivated teachers (Swanepoel & Booyse, 2003).

When the new government took over after the first democratic and national elections in 1994, curriculum change was inevitable and at the heart of educational transformation. One of the first tasks undertaken by the democratically elected South African government

in 1994 was to reform education so as to reflect the multicultural South African society. The new national curriculum, *Curriculum 2005* (C2005), was launched by the National Department of Education in 1997, and was informed by the principles of outcomes-based education (OBE). *C2005* was later revised to form the Revised National Curriculum Statement (RNCS) and the National Curriculum Statement (NCS). The two Curriculum Statements were revised to form the Curriculum and Assessment Policy Statement (CAPS) document. Learning Outcome 3 of the policy document of the RNCS and NCS (Natural Science and Life Sciences) states that indigenous knowledge systems must be included in the curriculum (Department of Education, 2002). In the CAPS policy document, Learning Outcomes were replaced by three broad subject-specific aims which relate to the purposes of learning science. Specific Aim 3 in the CAPS is equivalent to Learning Outcome 3 of the Curriculum Statement documents. Specific Aim 3 relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science (Department of Education, 2011). When this thesis commenced in 2006, the term Learning Outcome was used in OBE. However, when CAPS was introduced in 2012, the term Learning Outcome was replaced by Specific Aim. But, Learning Outcome was used throughout this study, and thus the term Learning Outcome, and not Specific Aim, has been used throughout this thesis.

In OBE the roles of the teachers and the learners are different from those under apartheid education. The traditional teachers' role of transmitting knowledge to the learners became obsolete. The teachers' role has therefore changed from that of a sole custodian of knowledge to that of a facilitator of the learning process, while the learners' role on the other hand changed from being a passive recipient of knowledge to one who was in charge and responsible for his/her own learning (Department of Education, 1997c). Teachers therefore had to change from a teacher-centered teaching and learning approach to learner-centered OBE teaching and learning strategies.

Learning Outcome 3 (LO3) of the RNCS and NCS for the Natural Science and Life Science states "that the learner will be able to demonstrate an understanding of the

interrelationship between science and technology, society, and the environment” (Department of Education, 2002: 10). Therefore it is assumed that the teachers themselves are aware of such interrelationships and convinced of their significances. Also, the assumption underlying the curriculum statement is that the science teachers have the necessary knowledge and pedagogical skills to bring about the integration of science and indigenous knowledge.

Teachers had an important role to play in guiding the transformation and the implementation of the integration of science and IK in the classroom. Studies on science curricula in Africa conclude that the teaching and learning of science is not successful because the subject is not linked to the learners’ everyday life experiences (Dlodo, 1999; Dzama & Osborne, 1999; Shumba, 1999). What happens in the classroom is critically dependent on the skill, commitment, vision, and attitude of the teacher. It is crucial that the teacher must have a more than adequate understanding of indigenous knowledge to deal with the learners’ understanding, lack thereof or even possible misconceptions of the phenomenon.

5.2 The objectives of the study

The present study investigated whether teachers integrated scientific knowledge and indigenous knowledge, as required by the RNCS (Department of Education, 2002) within selected classrooms of the Western Cape Province. The study was guided by the following objectives:

- a) To adapt and validate a questionnaire for investigating the science teachers’ understanding of indigenous knowledge, as well as the problems they encounter when implementing LO3 in Natural Science and Life Sciences.
- b) To describe the science teachers’ understanding of indigenous knowledge and scientific knowledge in both quantitative terms (i.e., using the questionnaire) and qualitative terms (i.e., using additional classroom observations and interview data).

- c) To provide indigenous knowledge resource material to the teachers, and to carry out specific interventions yielding successful integration of indigenous knowledge in the science curriculum, and
- d) To establish how successful the resource material was in assisting the teachers to integrate indigenous knowledge in the science curriculum.

The study will therefore seek answers to the following research questions with regard to the Western Cape Province:

- 1) To what extent are the science teachers in the Western Cape Province integrating scientific and indigenous knowledge, as required by the Department of Education? If they are not implementing the integration, what are their reasons for not doing so? (objective a)
- 2) What are the teachers' views about and understanding of the nature of science and indigenous knowledge as well as their view on how the two worldviews can be integrated in the science classroom? (objective b)
- 3) How effective was the treatment in enhancing the teachers' ability to integrate science and indigenous knowledge in the classroom? (objective c and d).
- 4) To what extent can the model of Snively and Corsiglia (2001) be useful for measuring change as the teachers implement the integration of indigenous knowledge in the science curriculum? (objective c and d)

In order to provide accurate, credible, and trustworthy answers to the above research questions, the study utilised a contemporary research design, the multi-method approach (e.g., Hammond, 2003; Morse, 2003; Tashakorri & Teddlie, 2003).

5.3 Research design

In carrying out this study, a multi-method approach (Hammond, 2003; Johnson & Onwuegbuzie, 2004; Tashakorri & Teddlie, 2003) was employed where different approaches or methods are used in parallel or sequence but are not integrated until

inferences are being made (Jonson, Onwuegbuzie & Turner, 2007). When using a multi-method design, data are not usually combined within projects and each study is planned and conducted to answer a particular sub-question (Morse, 2003). Using a multi-method approach is to draw from the strengths and to minimize the weaknesses of both qualitative and quantitative methods in single research studies (Johnson & Onwuegbuzie, 2004: 18). Thus, there is a wide consensus that using different types of methods can strengthen a study (Cresswell, Plano- Clark, Gutmann & Hanson, 2003; Tashakorri & Teddlie, 2003). Many investigators have verified that using both quantitative and qualitative methods in a single study is becoming increasingly popular (Tashakorri & Teddlie, 2003).

One of the major advantages of the multi-method approach is that a large variety of data sources, as well as analyses, can be used to understand complex, multifaceted institutions or realities (Hanson, 2003; Tashakorri & Teddlie, 2003). Another advantage is that the multi-method approach can provide answers to research questions that the other methodologies cannot (Tashakorri & Teddlie, 2003). Firstly, it combines the theory generation (exploratory) and theory verification (confirmatory) aspects of qualitative and quantitative research respectively. Secondly, it offsets the disadvantages that either quantitative or qualitative methods have by themselves. Furthermore, the multi-method design provides the opportunity for providing a greater diversity of diverged views. Finally, inferences can be made at the end of each data collection phase, leading to questions that can be answered at the end of each phase (Hanson, 2003; Tashakorri & Teddlie, 2003).

The sequential design was used as the implementation strategy of the multi-method approach. The sequential design is easy to implement because the steps fall into clear separate stages (Creswell et al., 2003). A characteristic of the sequential multi-method design is the collection and analysis of the quantitative data, followed by the collection and analysis of the qualitative data (Tashakorri & Teddlie, 2003). In the present study, priority was given to the quantitative data which was collected and analysed first. The quantitative data was collected to establish the teachers' understanding of indigenous

knowledge and the problems they encountered in their integration of science and indigenous knowledge in the classroom. The quantitative were analysed and the findings were used for further data collection during the second phase. Resource materials were developed for teachers as well as learners and the teachers were trained in methods how to integrate indigenous knowledge in their science lessons. To establish the effectiveness of the intervention a quasi-experimental design was designed. The qualitative data was collected by means of classroom observations, as well as interviews with teachers and learners.

5.4 Limitations of the study

The present study has some limitations that need to be taken into account when considering the study and its contributions to the field.

Firstly, in the present study, quantitative and qualitative data were collected. The collection of both sets of data had limitations with regard to language issues. Although the participants in the main study were teachers, the sample consisted of teachers whose home language was isiXhosa, with English their second or third language. A language barrier may have existed when they were completing the questionnaire, as well as during the classroom observations. Therefore, these teachers may have expressed themselves more clearly had they expressed their views in the questionnaire in isiXhosa, thus giving greater insights into the results. In a similar manner, a language barrier may have existed during the classroom observations. The lessons were conducted in English (the second or third language of the learners). During the lessons the learners may have expressed themselves more clearly, and been less “shy” had they expressed their views in isiXhosa.

Secondly, when the researcher interviewed the learners, they were provided with the opportunity to respond to a translator in isiXhosa. However, the learners chose to be interviewed in English. In the section on ethical issues (Chapter 3, page 65) steps were explained regarding ethical considerations in order to maximise the trustworthiness of the

results. Given these steps, it was very likely that the learners were confident during the interviews to answer the questions in an open and honest manner.

5.5 Providing answers to the research question

Results from the statistical analysis of the quantitative data were integrated with the results of the qualitative data analysis in order to provide a comprehensive picture of the integration of scientific knowledge and indigenous knowledge in science classes in the Western Cape Province. The results of the qualitative inquiry (i.e., classroom observations as well as teacher and learner interviews) are woven into the results of the quantitative data. Naidoo (2005) distinguishes three forms in which indigenous knowledge can be integrated into the science curriculum. First, IKS is incorporated *into* Western science. This will be considered as '*the incorporationist*' approach in the analysis. Second, IKS and science are given equal status and IKS is integrated *with* science. This will be considered as '*the integrationist*' approach in the analysis. Third, the mechanism of integration is not specified and IKS and science are taught side by side. The two knowledge systems are accorded equal status and this will be considered as '*the separatist*' approach in the analysis. These three approaches are analytical approaches and that each teacher uses aspects of all three approaches. However, for the purpose of analysis, it is possible to develop each approach and to explain how a teacher implements indigenous knowledge in his/her science lessons in three different ways. In the next section the research question will be answered.

5.5.1 Research Question 1

To what extent are the science teachers in the Western Cape Province integrating scientific and indigenous knowledge, as required by the Department of Education? If they are not implementing the integration, what are their reasons for not doing so?

This question is actually two questions in one. First, it asks about whether teachers are implementing the integration of indigenous knowledge and scientific knowledge in the

science classrooms. Second, it asks for reasons if indigenous knowledge and scientific knowledge are not being integrated.

In answering the first part, the quantitative evidence (Chapter 4, page 113) show that nearly half of the respondents (47%) indicated that they did not integrate indigenous knowledge and scientific knowledge. In answering the second part of the question, reasons as to why the teachers were not integrating indigenous and scientific knowledge, were sought. As the quantitative evidence could only provide limited information to explain these results, a qualitative inquiry was embarked in order to create a more comprehensive picture of the reasons for not integrating the two knowledge systems. As shown in Table 4.18 (page 121), three themes emerged as the reasons for not implementing the integration of the two knowledge systems, namely, a lack of training; a lack of resources; and lack of indigenous knowledge by learners. Each of these three themes consisted of a number of sub-themes. The section that follows describes each of these themes.

Why were the teachers not integrating IK with Scientific knowledge?

a) Lack of training

As indicated in Table 4.18 (page 121), lack of training and lack of knowledge of indigenous knowledge were the two aspects that were the most frequently mentioned by respondents to the survey under the first theme. This finding is in agreement with Jansen's (1998) argument that one of the reasons *C2005* would not be successful was that the new curriculum required trained and retrained teachers and that a re-engineering of the entire education system was needed to support the reform. There was a lack of guidelines from the Department of Education about how teachers were to access IKS or integrate it with school science (Ogunniyi, 2006). Ogunniyi (2007a) asserts that teachers were in opposition to *C2005* because, first, they have been schooled in Western science and hence are more familiar with that worldview than that of IKS; second, the new instructional approaches demanded by the new curriculum; and third, the lack of clarity

on how the IKS could be integrated into the science curriculum. Simon, Erduran and Osborne (2006) argued that a curriculum that emphasizes alternative goals for classroom pedagogy in a context where conceptual goals predominate is notoriously difficult to implement unless a well-planned and supportive teacher programme is in place.

b) Lack of resources

As indicated in Table 4.18 (page 121), lack of resources and the time to research indigenous knowledge are the two aspects most frequently mentioned by respondents to the survey under the second theme. This finding is in agreement in Jansen's (1998) argument that one of the reasons OBE would fail is that teachers needed new forms of learning resources (such as textbooks and other aides) which were consonant with an outcomes-based orientation and opportunities for teacher dialogue and exchange as teachers co-learn in the process of implementation. When the new curriculum was implemented, one component, namely Learning Outcome 3 (LO3), expected the teachers to integrate IKS into the science curriculum. This learning outcome remained a challenge for teachers because the teachers may not necessarily know the various IKS within South Africa and may not know how to teach IK (Odora-Hoppers, 2002; Ogunniyi, 2004).

According to the Department of Education (2002), the South African issues such as, for example, the existence of different worldviews creates interesting challenges for curriculum policy, design, materials and assessment. Science curriculum development which takes into account of worldviews and indigenous knowledge systems is in its early stages and will be addressed with enthusiasm by many teachers. This Curriculum Statement creates an invitation for such research and development, and in this way it is an enabling document rather than a prescriptive one. According to the Department of Education, teachers are the chief contributors to the transformation of education in South Africa and, as such, the Curriculum Statement (2002) envisions teachers who are researchers and lifelong learners. Jansen (2003) and Chisholm (2000) argue that this reform agenda represents a tall order for the majority of South African teachers who are ill or under-qualified to teach science, especially at the senior secondary level.

According to Ogunniyi (2005), most recent science textbooks acknowledge the prevalence of IKS amongst learners. However, these textbooks pay little or no attention to the modes of inquiry existing within IKS or the contexts in which learners live. The availability of teaching and learning resources influence the presentation of science lessons in the classroom (Jansen, 2003; Rogan & Grayson, 2003). According to Cross et al. (2002), given the poor training of teachers and the lack of resources, most teachers found it difficult to know what to teach and tended to act as mere technicians without the necessary conceptual and content tools. Naidoo (2002) found that resources for IKS teaching were not available or unknown to teachers. Therefore, teachers could not implement IK in their lessons if IK resources were not available.

c) Learners

As indicated in Table 4.18 (page 121), learners that have a lack of background knowledge of indigenous knowledge and learners who are unaware of the cultures and views of others, are the two aspects most frequently mentioned by the teachers under the third theme. Keane (2008), in a research study in Kwa-Zulu Natal in South Africa, had a similar finding where she had difficulty eliciting any kind of knowledge about nature from students.

According to the Department of Education (2002: 10):

Indigenous or traditional technologies and practices in South Africa were not just ways of working; they were ways of knowing and thinking... Much valuable wisdom has been lost in South Africa in the past 300 years, and every effort is needed now to discover it and to examine its value for the present day.

IK is stored in culture in various forms, such as traditions, customs, folk stories, folk songs, folk dramas and myths (Masoga, 2004). Teachers must involve learners to collect folk stories, folk songs, legends and myths that are retold in their communities. This would encourage learners to learn from their parents, grandparents and other adults in their community. In this manner, indigenous people would also get an opportunity to participate in curriculum development (Masoga, 2004). IK can play a significant role in

education about the local area. Therefore, teachers should start with the knowledge about the local area with which learners are familiar with, and then gradually move to the knowledge about regional, national and global environments.

Another problem mentioned by teachers which impeded the successful integration of IK and science was that learners were unaware of the culture and views of other learners (Chapter 4, page 132). During the classroom observation of Bet and Wayne it was seen that the learners were not tolerant to the views of other learners. The learners in Bet and Wayne's classrooms were not satisfied with the answers given by some of the learners. There are many instances where African beliefs and Western science, even at the practical day-to-day level, are contradictory. Cultures embody many practices and beliefs; some of them are fine, some not; some are true and others are false (Irzik & Nola, 2007). We can respect the right of certain learners to believe in, say witches, but we have no obligation to respect the belief in witches itself. It is the moral responsibility of the teacher to show what is wrong with a belief in a pedagogically appropriate way (Irzik & Nola, 2007).

Learners must be culturally knowledgeable, and thus will be able to engage effectively in learning activities that are based on traditional ways of knowing (Masoga, 2004). Culturally knowledgeable learners will have an understanding of the relationship between the worldview and the way knowledge is formed and used, as well as how the cultural values and belief influence the interaction of people from different cultural groups (Masoga, 2004).

In conclusion, the findings of this study for research question 1, as to the reasons why the teachers in the Western Cape Province are not implementing the integration of indigenous knowledge in their science lessons, are in agreement with other researchers. Similar findings for not implementing indigenous knowledge in the science curriculum have been reported by other researchers (i.e., Aikenhead, 2006; George, 1999a; Ogunniyi, 2006; Shizha, 2005). According to Aikenhead (2006), some of the reasons include a lack of available classroom materials, reliance on a single national textbook that

contains little or no indigenous content, preoccupation for preparing students for high stake examinations and success at university as well as fear of losing control over the class. Shizha (2005) asserted that in countries in Africa where it was attempted to include indigenous knowledge in the science curriculum, teachers were not familiar with what indigenization entailed since there were no materials that explained and gave direction to what was to be taught and how it was to be taught. The majority of the African teachers also lacked the pedagogical skills required to embark on Africanizing the curriculum (Shizha, 2005). In South Africa, Ogunniyi (2006) also reported similar findings.

From the preceding discussions it is apparent that there were numerous reasons why the teachers could not or did not implement the integration of indigenous knowledge in the science curriculum as required by the Department of Education. The question that can be asked is: can the teachers be assisted in integrating the science and indigenous knowledge in the classroom. This question will be answered in the next section.

As shown in Table 4.19 (page 123), three themes emerged as to describe the assistance teachers required to implement the integration of indigenous knowledge in the science curriculum, namely, workshops; resources; and advisory assistance. Each of these three themes consisted of a number of sub-themes. The section that follows describes each of these themes.

How to assist teachers to integrate IK with scientific knowledge?

a) Workshops

As indicated in Table 4.19 (page 123), the teachers in this study indicated that they wanted workshops where they could be taught how to develop and test IKS material by means of hands-on training. When *C2005* was implemented, there were negative reactions in all sections of the South African society, of which teachers' unions were at the forefront (e.g., Jansen, 1997; Ogunniyi, 1997). In response to these protests, various seminars, symposia and workshops have been organised to ameliorate the situation (e.g., Bak, 1999; Ogunniyi, 1997). However, the main criticism of these workshops is the "one

shoe fits all” approach of these workshops. Attempts to improve the teachers’ understanding the nature of IKS without helping them to translate this knowledge into classroom practice have been found to be inadequate to successfully implement the integration of IK in the science curriculum (Ogunniyi, 2004). Several studies have further shown that the most effective way to get teachers to understand the nature of IKS or how to integrate IKS and science is to engage the teachers in long-term mentoring (Ogunniyi, 2006, 2007a, b).

b) Resources

As shown in Table 4.19 (page 123), the teachers in this study indicated that they wanted learning support material and examples of activities to assist them to integrate IKS and science in their classrooms. Naidoo (2002) found that resources for IKS teaching in South Africa were not available or unknown to teachers. Therefore, teachers could not implement IK in their lessons if IK resources were not available. There is also a lack of indigenous content in science textbooks: Table 4.17 (page 120), shows that the science teachers in this study indicated that the textbooks were not useful because they did not cover enough in-depth studies, the examples were superficial and the learners did not identify the examples in the textbook.

c) Advisory assistance

As shown in Table 4.19 (page 123), the teachers in this study indicated that they wanted assistance from a source from the department to show them how to implement core knowledge in relation to LO3. Reform of the South African education system resulted in a new policy, namely C2005, being launched in 1997. However, according to Rogan (2003: 1171), all too often the attention and energies of policy-makers and politicians are focused on the ‘what’ of desired educational change, neglecting the ‘how’. Teachers voiced their opposition to C2005 because they were only considered as implementers of policy, and had no say in the development of the new policy. As indicated by the respondents in this study, teachers want professional development programmes from the

Department of Education. These should not be never to-be-repeated in-service (INSET) programmes, but long-term mentoring programmes by Department of Education officials.

5.5.2 Research question 2

What are the teachers' views and understanding of the nature of science and indigenous knowledge as well as view on how the two worldviews can be integrated in the science classroom?

The quantitative evidence (Table 4.5, page 105) was used to analyse the teachers' understanding of indigenous knowledge. An analysis of the results show that 55% of the respondents had some idea of what indigenous knowledge was. Furthermore, Table 4.13 on page 116 reveals that the most frequent descriptions by the respondents on what IK were included the words that IK was not proven and that IK exist locally. The cross tabulations for the correct answers for IKS (Table 4.8, page 108) paint a gloomy picture of the teachers' knowledge of IK. The respondents all obtained a score of 20% for four and more correct answers out of a possible six. The only exceptions are the Xhosa-speaking teachers, who obtained a score of 25% for four or more answers correct out of a possible six, and the teachers with less than one year teaching experience, who obtained a score of 30% for four or more correct IKS answers out of a possible six. The latter is on the one hand surprising, but also on the other hand encouraging. These teachers only recently finished their pre-service training, and it is thus an indication that the Higher Education institutions are making an effort to include IKS in their curriculum to teach to their students.

The findings of this study are in agreement with the findings of other studies. Numerous studies have consistently shown that teachers hold inadequate understandings of the nature of science and indigenous knowledge systems (e.g., Abd-El-Khalick, 2005; Aikenhead, 1996; Jegede, 1995; Ogawa, 1995; Ogunniyi et al., 1995). Michie (1999) pointed out that teachers in secondary schools tend to lack knowledge of indigenous knowledge. According to Michie (1999), the best site to teach indigenous knowledge is

primary schools which tend to have integrated curricula. Science teachers would need to have a full knowledge of the indigenous knowledge system operating in the communities from which their learners come (George, 1999a). Teachers are encouraged to conduct research in communities surrounding their schools as a way of upgrading their background knowledge of indigenous knowledge (Semali, 1999a).

Teachers must know the cultural diversity of their learners before they can cope with 300 learners daily from different cultures to produce optimum learning. However, many teachers are believed not to be successful in multicultural classes because they have a limited knowledge of the history and culture of their learners (Atwater, 1994). Teachers should be aware that the learners do not come to the classroom with *tabula rasa* minds. In the African context, learners come to the classroom with a worldview which may not be scientifically correct as a result of their cultural backgrounds. Teachers should make a concerted effort to identify those elements of the learners' culture which differ from the scientific culture, and to treat the elements of the learners' culture with the appropriate care they deserve (Kesamang & Taiwo, 2002). If the socio-cultural background of the learner is indifferent to the learning of science, the learner may find it difficult or perhaps impossible to learn science (Cobern, 1996a).

The quantitative evidence (Table 4.12, page 115) was used to analyse the teachers' understanding of scientific knowledge. Table 4.12 reveals that the most frequent descriptions on what scientific knowledge was, included: proven, tested and involved experimentation. Many of the sampled teachers subscribe to the traditional, largely empiricist and positivistic understanding of the science, which holds science to be made up of provable truths, unfettered with belief and dealing only with tangible reality (Ogunniyi, 2009a). However, science is not provable or verifiable. All that can be said is that scientific knowledge is testable, confirmable, and falsifiable, or can attain a high degree of credibility (Ogunniyi, 2009a). What this means is that no matter what scientific idea is considered, once disconfirming ideas begin to accumulate, at least we know that that notion is untrue (McComas, 1998; Ogunniyi, 2009b).

The quantitative evidence (Table 4.14, page 117) was used to analyse the teachers' understanding of the differences between indigenous knowledge and scientific knowledge. Table 4.14 reveals that, in answering this question, there is a clear indication that the respondents in this study considered scientific knowledge as superior to that of indigenous knowledge and that the respondents subscribe to a faulty view about science as well as the nature of indigenous knowledge. According to the responses, the respondents indicated that first, scientific knowledge was universal and that indigenous knowledge was local knowledge; and second, scientific knowledge was repeatedly tested and proven whilst indigenous knowledge was not tested and proven. The responses also reveal at least two types of myths. The first type of myth deals with matters of truth and belief. The second type of myth deals with non-testable presuppositions, assumptions and superstition. The responses include for example that scientific knowledge is dynamic and can develop from time to time whereas indigenous knowledge is not changing; scientific knowledge is proven and known worldwide whilst indigenous knowledge is local and mostly unproven. By virtue of the differences in the fundamental assumptions supporting science and indigenous knowledge, it is obvious that the two knowledge systems are based on distinctly different myths, assumptions and paradigms. Whether within the scientific or the indigenous knowledge perspective, each assumption, no matter how contentious or preposterous it might seem from another worldview perspective, can only be taken for granted than proven. When providing examples of how indigenous knowledge and scientific knowledge differ, the respondents emphasized modern medicines and traditional medicines.

One central theme to the successful implementation of the integration of indigenous knowledge in the science curriculum is the teachers' instructional methods. Table 4.11 (page 113) reveal that the teachers in this study ranked 'Starting the lessons with the learners' ideas before presenting the scientific view' as the most important instructional method. This finding has also been reported by other researchers (e.g., George, 1999a; Roschelle, 1995; Strangman & Hall, 2004). One of the more obvious curriculum spaces for indigenous knowledge is the constructivist strategy of mobilizing prior learning, the tuning in and bringing forth of what is known and meaningful to the learners, so that the

curriculum provides relevant learning challenges that engages and build on existing knowledge (O'Donoghue & Neluvhalani, 2002). The implications for teaching are that teachers should begin their lessons by ascertaining the nature of the learners' worldview perspectives found in their socio-cultural environment (Jegede & Okebukola, 1991). Teachers should also increase the amount of discussions that take place during each lesson (Lawrenz & Gray, 1995). The learners must also be actively involved in open discussions to allow alternative conceptions (Snively & Corsiglia, 2001). The introduction of indigenous knowledge in the formal school science curriculum warrants the use of innovative instructional approaches such as: use of holistic or integrated approaches; adhering to the constructivist wisdom of starting with learners' prior knowledge before introducing them to new ideas; extending classroom discussion to include other ways of knowing; providing learners opportunities to undertake problem-solving activities; and inviting IKS experts into class (Ogunniyi & Ogawa, 2008).

5.5.3 Research question 3

How effective was the treatment in enhancing the teachers' ability to integrate science and indigenous knowledge in the classroom?

The researcher embarked on a qualitative inquiry in order to train the science teachers in how to integrate indigenous knowledge in the science classrooms. The researcher chose a workshop as an intervention to improve the teaching skills of the teachers and to develop new methods of teaching. The purposes of the workshop (Chapter 3, page 87) was to introduce different concepts (such as indigenous knowledge, Western science); to develop the teachers' understanding of various concepts of indigenous knowledge and scientific knowledge through a series of activities; to provide suggestions and models for integration of indigenous knowledge and scientific knowledge; and to provide resource material for teachers as well as learners.

To establish how effective the intervention (Chapter 3, page 84) was, the researcher chose a quasi-experimental design. The researcher purposefully selected 11 teachers to

participate in the second phase of the study. These teachers participated in the survey and completed the NOIKQ questionnaire and were selected for their particular interest in the research study. Five teachers participated in the workshop and interviews. All 11 teachers were observed in their classroom presenting a lesson. The section that follows explain the effectiveness of the intervention using the data collected through the classroom observations, as well as the teacher and learner interviews.

- a) The first experimental group of teachers who had received training (Bet, Mikes and Thabisa)

The manner with which these teachers incorporate indigenous knowledge in their science lessons differed. Bet's belief that Western science is "real science" seems to have been largely influenced by her education where Western science was perceived as superior while subjugating other knowledge systems. This has persisted in her classroom teaching and has influenced her level of engagement with IKS. In her approach to IKS teaching, she uses an "incorporationist" approach in which she incorporates IKS into Western science. According to Bet, IKS is a subset of Western science, where the latter has a higher status.

Mikes, like Bet, was also educated in Christian National values and principles during schooling. However, he recognises that all cultures must be afforded equal respect and opportunities in the new curriculum. Therefore he uses the "equal but separatist" approach. In this approach, all cultures are promoted and acknowledged and different worldviews are allowed to co-exist next to each other (Appendix 13, page 285). Western science and indigenous knowledge are each valued for their own merits.

Thabisa, like Bet and Mikes, was also educated in Christian values and principles during her schooling. Thabisa, as a Black South African, attended schools consisting of learners and teachers of similar culture to hers (IsiXhosa). In her approach to IKS teaching she takes an "integrationist" approach. In this approach she moves effortlessly between IKS and Western science, making constant links between the two knowledge systems.

Bet, Mikes and Thabisa's approach to teaching IKS is located within the constructivist paradigm (step 2 of the Five-step model) with reference to how learners engage with building knowledge (Appendix 13, pages 271, 283 & 295). In this approach, a lesson starts with the learners' prior knowledge before introducing them to new concepts. This approach has some resonance with the views of Jegede and Aikenhead (1999) who maintained that the prior or indigenous knowledge of the learner is of significance in accomplishing the construction of science meaning in a new situation. The three teachers differed in the manner in which they established the prior knowledge of the learners.

Mike's strategy was one of using IKS as a stepping stone by building on what the learners already know about science concepts (Appendix 13, page 283). The IKS was used as a device to assist the learners with understanding Western science. This was accomplished by the teacher asking questions to the learners. According to Mosimege (2005), using IKS as a springboard to access Western science would appear as if IKS has no value in itself. Thabisa also started the lesson with indigenous knowledge (Appendix 13, pages 295 & 300). However, unlike Mikes, Thabisa established an African Indigenous framework at the start of the lesson, building on what the learners already knew about traditional cultural practices and healing. Thabisa skillfully used the prior knowledge of the learners, and built on the existing knowledge, so that the curriculum became meaningful to them and provided relevant learning challenges to the learners. Bet started the lesson with Western science and then introduced indigenous knowledge (Appendix 13, page 271). By means of the question and answer method, IK was drawn upon in ways that were comfortable to the learners. According to Aikenhead (2002), where Western science is used to learn more about the indigenous world of the learners, celebrates the co-existence of both sciences, a condition essential to culturally sensitive lessons.

The patterns of classroom interaction in the case of all three teachers changed from a teacher-centered one to one of more teacher-learner interactions. The atmosphere in the classrooms changed through the inclusion of indigenous knowledge based on the

experiences and knowledge of the learners (Appendix 13, page 304). In these lessons the teachers became the learners and the learners became teachers. This phenomenon did not exist in conventional science classes where the teachers are the experts and the transmitters of knowledge. In the case of all three teachers, small group discussions, debates and focus group discussions was used to compare the western scientific and indigenous perspectives, step 3 of the Five-step model (Appendix 13, pages 291, 296 & 304). This step seeks to bring perspectives and experiences from different contexts into critical reflective dialogue. In these discussions, the learners were active and more peer interactions were evident. Thabisa's use of activities that built on the learners' personal IK derived from their culture promoted in an increase in input by learners. Bet's learners reacted positively to IKS and the emergence of the "learner voice" during the class debate opened up issues of IK. Learners were more open, and this allowed the teacher more critical insights into the learners' personal beliefs. This reflective dialogue allowed for the existence of different viewpoints which might help to confront ignorance and prejudice (step 4 of the Five-step model).

In the case of all three teachers the learners evaluated the effect of the indigenous knowledge on their personal actions, how did the integration of the two perspectives make each learner feel as well as the possibilities of the use of IK in future inquiries (Step 5 of the Five-step model). The learners of Mike commented that they would use the IK of their parents in future because it was cheaper than going to the doctor. After the lesson, Bet commented how the learners enjoyed the lesson. Clarke and Ramaphale (1999) reported that classes literally spring to life when teachers draw on the cultural backgrounds of learners and how the atmosphere of the classroom changed as learners had opportunities to speak about their own beliefs in a science lesson.

- b) The second group of experimental teachers (Charles and Gareth) who were observed only once (after the training)

Charles and Gareth formed the second experimental group of teachers who received training in the integration of indigenous knowledge and scientific knowledge (Chapter 4,

pages 154 and 156). These teachers were only observed once, namely two weeks after they were trained. Charles, like Gareth, was educated in Christian National values and principles during their schooling where Western science was fully epistemologically adequate while subjugating other knowledge systems.

The manner in which these two teachers incorporated indigenous knowledge in their science lessons differed. Charles had the security of his personal IKS that he had gained from an insider perspective through cultural practices and direct transmissions of elder knowledge while growing up. Gareth, on the other hand, recognised that all cultures must be given equal respect and equal opportunities in the curriculum. Charles established an African indigenous framework at the beginning of the lesson; building on what the learners already knew about cultural practices of healing and linked it to associated concepts (Step 2 of the Five-step model). Gareth, on the other hand, used a concept of Western science, namely, biodiversity which was studied, and the topic was enriched and exemplified by additional relevant indigenous content. According to O'Donoghue and Neluvhalani (2002: 131):

One of the most obvious spaces for IK processes is constructivist strategy of mobilising prior knowledge, tuning in and bringing forth of what is known and meaningful to the learners so that the curriculum provides relevant learning challenges that engage and build on existing knowledge

The two teachers differed in the manner in which they established the prior knowledge of the learners (Step two of Snively). Charles divided the learners into small groups to research what they knew about medicinal plants from indigenous knowledge. Gareth had discussions of the ways in which society view plants and develops resources, as well as the reasons why society do so. This formed the basis for discussions on the environment, appropriate technology, justice and sustainable societies.

The atmosphere in the classroom also changed through the inclusion of indigenous knowledge based on the experiences and knowledge of the learners. The introduction of indigenous knowledge examples of medicinal plants added interest and excitement to the

science classroom. In the case of both Charles and Gareth (at the latter stages), the learners were more active in the small group discussions.

The lessons of both Charles and Gareth were only from an indigenous perspective. Therefore, no opportunities were provided to the learners for step three of the Five-step model, namely to compare the indigenous and western scientific perspective. In the case of both Charles and Gareth, the learners did not reflect or consider the consequence of each perspective (Step four of the Five-step model) nor did they evaluate the effect of personal actions or possibilities in terms of future enquiries (Step five). However, Gareth highlighted the current approaches to resource management which may contribute to the loss of biodiversity. Gareth emphasised to the learners the relationships between science, technology and culture and the values of the society within which we operate.

c) The control group of teachers who did not receive training

The six teachers, namely Ursula, Jonas, Manelli, Bradley, Sutwana and Wayne formed the control group and did not receive any training in the integration of indigenous knowledge and scientific knowledge (Chapter 4, pages 136 & 146). Ursula, Jonas and Manelli were observed twice, namely, a first observation followed by a second observation two weeks later. On the other hand, Bradley, Wayne and Sutwana were observed only once.

The manner in which these six teachers engaged with IK in the classroom was more or less similar. Ursula, Bradley and Wayne were all educated in Christian National values and principles during their schooling. For these teachers, Western science is considered superior and indigenous knowledge inferior (Chapter 4, page 147). This influenced their level of engagement with IKS in their classrooms. Bradley for example mentioned to the class that he did not believe in traditional medicines and that he would rather go to the medical doctor than to a traditional healer. The researcher can deduce that Bradley

maintained his loyalties to science. According to Aikenhead (2006), this can be considered as one of the salient influences on a teacher's orientation, which is very difficult to change. One of the teachers (Wayne) acknowledged to the class that he did not know many of the indigenous examples that they had mentioned during the lesson. On the other hand, another teacher (Ursula) thanked the learners at the end of the lesson and informed them that she as a Westerner had learnt a lot about traditional healers during the lesson. The utterances of these three teachers concur with some of the reasons given by the teachers for not implementing an indigenous curriculum, namely, fear of losing control over the class (i.e., open-ended activities and unpredictable outcomes) in the case of Wayne and a lack of confidence in connecting science content to learners' everyday lives. Jonas, Manelli and Sutwana were also educated in Christian National values and principles. However, all these teachers were Black teachers and had been exposed to learners and teachers of a culture similar to theirs (IsiXhosa). Therefore these teachers were more knowledgeable about indigenous practices that were mentioned by their learners.

All the teachers in the control group used the constructivist paradigm with reference to how the learners engage with building knowledge (Step 2 of the Five-step model). These teachers firmly believed in constructivism where they must create experiences where learners must be actively engaged in making sense of concepts themselves in order to construct their own knowledge. The teachers took the learners' existing ideas and prior knowledge into account when planning their teaching activities. By means of the question and answer method the teachers established what the learners knew about the topic.

The lessons from the teachers in the control group were either only from an indigenous perspective or only from a western scientific perspective. The first lesson of Jonas and Manelli, as well as the lesson of Bradley and Sutwana, was only from a western scientific perspective. The second lesson of Jonas and Manelli, as well as the lesson of Ursula and Wayne, was only from an indigenous perspective. Therefore no opportunities were provided by the teachers to compare the indigenous and western scientific perspectives (Step 3 of the Five-step model). In the lessons which were from a Western science

perspective, the lesson was teacher-centered. The learners all sat quietly whilst the teacher was the transmitter of knowledge. However, in those lessons which were from an indigenous perspective, the learners were all excited and willing to explain their indigenous knowledge to the other learners. There were no reflections to consider the consequences of each perspective (Step 4) or evaluation in terms of future consideration (Step 5 of the Five-step model).

d) Comparison of the experimental group with the control group

When the experimental group of teachers is compared with the control group of teachers, questions that can be asked are: Did/could the participants integrate indigenous knowledge and scientific knowledge in their classrooms? Was the intervention successful and how can this success be measured? The classroom observation was analysed using a thematic approach (Chapter 3, page 93) and scores were awarded on a scale of one to three for each sub-theme of the five themes. The scores of each participant were represented visually (Chapter 4). In the first experimental group (Thabisa, Mikes and Bet) there was an improvement in the second classroom observation after the workshop (intervention). All these teachers obtained a maximum score of three for all the sub-themes (Chapter 4, pages 129, 133 & 136). This indicates that the learners were given the opportunity to compare the indigenous perspective with the scientific perspective. The consequences and values associated with the indigenous and scientific perspectives were also highlighted. The lessons of the teachers in the control group were either only from an indigenous perspective or from a scientific perspective. Thus, there were no comparison of the two perspectives, or the consequences and values of using the one or the other perspective was not highlighted by these teachers.

The experimental group of teachers (Thabisa, Mikes and Bet) who attended the workshop and had training in the integration of IK in their science lessons performed better in the classroom observations than the control group of teachers who was not exposed to the workshop and training. The workshop enhanced the experimental group of teachers' understanding of IKS and how to integrate IK and science in their classrooms. The

experimental group of teachers was more confident and willing to implement IK in their science lessons than the control group of teachers. What was also evident in the case of both the experimental and the control group was that when the lesson was from an indigenous perspective, the learners participated actively in the classroom.

5.5.4 Research question 4

To what extent can the model of Snively and Corsiglia (2001) be useful for measuring change as the teachers implement the integration of indigenous knowledge in the science curriculum?

Various models for “IKS in science teaching” exist in the literature, such as the “Research and Development Model” proposed by Aikenhead (2002) and the “Five-step Model” proposed by Snively (1995).

The Five-step model of Snively (1995) was used in this study because this model, besides having the potential for teaching IKS and Western science, retains a high degree of the culture of the learners. Snively (1995) outlines a five-step process for producing a Traditional Ecological Knowledge (TEK) unit in cross cultural science teaching. This model provides a general framework for exploring the two perspectives, which is Western science and IKS, while teaching about one concept or topic of interest. Snively and Corsiglia (2001) maintain that using the five-step model is not to establish whether one form of science is more relevant than another, but to develop scientific thinking and to ground the study of science within the actual world in which the learners live their lives.

The model builds on a constructivist view of learning, which is evident in the recognition it gives to personal knowledge, and brainstorming of concepts in step 2. In the classroom there are different personal knowledges, those that the learners bring and those that the teachers bring. According to Jegede (1996), the prior knowledge of the learners is determined by the cultural beliefs, traditions and customs governed by a worldview.

Learners bring to the classroom ideas based on prior experience, and children of different cultural backgrounds frequently interpret science concepts differently than the standard scientific view. Teachers need to understand the importance of not discrediting the IK that the learners bring to the classroom because this knowledge serves as a framework against which they learn science (Le Grange, 2007). Teachers therefore need to begin their science lessons with the prior knowledge that the learners bring to the classroom. The teachers who were trained, as well as those who were not trained, utilised different methods to establish what the learners knew about the topic. Mike, Ursula and Bradley used the question and answer method to establish what is known about the topic. Other teachers, for example, Bet and Charles, divided the learners into small groups in which the learners discussed the topic and then each group reported to the rest of the class.

The instructional approaches by teachers in South African schools focus on the transmission of scientific facts (Hewson & Ogunniyi, 2007). The focus of instruction should not be on presenting information so that non-western learners will accept the scientifically accepted notion of the concept, but must help the learners to explore the differences and similarities between their beliefs and Western science concepts (Snively & Corsiglia, 2001). In South African classrooms, learners experience cognitive dissonance when learning about certain phenomena in science classrooms (Le Grange, 2007). The notion of comparing the two perspectives as reflected in step 3 seeks to bring perspectives and experiences from different contexts into critical reflective dialogue. Step 4 allows for the existence of different viewpoints, which might help to confront ignorance, prejudice and stereotyping in the integration of IK in the science curriculum.

This reflective dialogue may be achieved in a number of ways. A possible setting is the small group discussions. The group would consist of learners of different cultural origins. Through the discussion process, the learners can be made aware that there exist different kinds of indigenous knowledge as well as personal science (Ogawa, 1995). The teacher will assume the role of a culture broker who will guide the learners between their life-world culture and the culture of science, and help them to resolve any conflicts. Ogunniyi (2004, 2006) and Ogunniyi and Ogawa (2008) suggest that learners must be provided

with opportunities to undertake problem-solving activities and to argue, dialogue, discuss and express themselves freely without feeling intimidated. According to Waldrup et al. (2007), it is important to utilise indigenous learning styles to enhance the learning process. The learners must be involved in discussions, both in and out of class, to explore learning and interest. The learners' indigenous knowledge and views are respected and utilised in the learning process (Waldrup et al., 2007).

All the teachers who were trained in the implementation of the integration of IK in the science curriculum utilised the above-mentioned strategies. Mike, Bet as well as Thabisa used small-group discussions, followed by discussions by the whole class. In these discussions, the learners argued and expressed themselves freely, but also respecting the indigenous science of their class mates. Bet on the other hand, used a combination of small-group discussions and role-play. Steps 3 and 4 of the model of Snively (1995) were therefore also accomplished by the teachers who were trained. The role of the teachers as culture brokers became one of helping the learners mediate between their personal meanings, their own culture based systems and the systems of school (Jegede & Aikenhead, 1999). Mike used a strategy for culture broking in science classrooms as suggested by Aikenhead (1996). After discussing explanations of IK and Western science, learners were asked to divide a sheet of paper in half, forming two columns: "Indigenous knowledge" and "Western science." The topic that was discussed was medicinal plants and learners would record their own ideas and beliefs about medicinal plants in the one column, and in the other column what they learnt about medicinal plants in the science classroom. This strategy enables the learners to consciously move back and forth between their everyday world and the world of science.

In the case of all the teachers who were trained, the learners evaluated the effect of the indigenous knowledge on their personal actions, as well as the use of IK in the future (step 5). The learners of Mike commented that in future they would not only go to the doctor, but may also use the indigenous knowledge of their parents. Going to the doctor was more expensive than using IK from their parents which was cheaper. Bet commented that there was a change in the attitude of the learners in the class. At the start of the

debate the learners were all interested in the profit that they would make. However, as the debate continued, the learners realised that the protection of the environment was more important than profits. The same sentiment was echoed by the learners in Gareth's class.

The lessons of the teachers who were not trained were all teacher-centered. There were small-group discussions, but these discussions were either only from an indigenous perspective or a Western science perspective. These teachers only utilised the first two steps of the Five-step model of Snively (1995). In step 3, namely "the idea of learners as researchers who explore their own lives and connect academic information with their own lived experience" is foreign to many schools. This step may therefore be a challenge for many teachers to accomplish.

The Five-step model of Snively (1995) provides a model which makes the integration of IK in science practical and provides opportunities to the learners to experience the science in school as relevant to their daily lives. This study has shown that those teachers who were trained using the Snively (1995) model found the model useful and assisted their teaching. However, research with larger samples must be done.

5.6 Implications of the findings

The findings of the study suggest generally that the integration of indigenous knowledge and scientific knowledge is not successful in selected classrooms in the Western Cape Province. This implies a failure of the implementation of the integration of IK and science. However, the subsequent qualitative data analysis revealed varying degrees of successful integration of IK and scientific knowledge by the teachers in selected classes. These differences are attributable to factors such as resource provisioning (teachers as well as learner teacher support material such as textbooks) and class sizes.

The results of this study suggest that several challenges face classroom teachers. The inclusion of IK in the school curriculum is for many science teachers problematic. These teachers find indigenous knowledge unimportant and indigenous ways of knowing may

not be recognised by some teachers. However, there are also those teachers who think that indigenous knowledge is beneficial because “indigenous knowledge can contribute to educational relevance and to redressing past colonizing hegemony” (Keane, 2008: 588).

Opinions about the authenticity or otherwise of indigenous knowledge vary. On the one extreme there are scholars who regard indigenous knowledge as folklore with little or no scientific content, as well as the fact that it includes beliefs, values, and practices. Snively and Corsiglia (2001) also argue that scientists refuse to acknowledge indigenous knowledge as “science” due to its spiritual basis. At the other extreme are those who assert that indigenous knowledge in every sense of the word is scientific. Science is a body of knowledge with replicable steps or procedures for objective verification and validation of knowledge claims (Onwu & Mosimege, 2004). Onwu and Mosimege (2004) question whether IKS should be subjected to the same verification or validation processes as with science or scientific explanations. The main implication for all teachers is validating indigenous knowledge. The teachers in this study validated IK in one of three ways. The first way in which the teachers validated IK was those teachers whose frame of reference is Western science, and they validate indigenous knowledge against modern science. These teachers started their lessons with Western science and incorporate IK into their lesson. This practice of validating IK against modern science implies that Western science is still considered as superior to other forms of knowledge, and that IK is seen as inferior in status to modern science. The second way in which the teachers validated IK was those teachers who validate IK against their personal knowledge. These teachers either integrated IK and scientific knowledge or dealt with IK and scientific knowledge separately. These teachers viewed IK as a domain of knowledge with equal value to Western science. The third way in which the teachers validated IK was to accept all IK brought by the learners. These teachers did not validate IK and their frame of reference was Western science in most cases, and the worldview and culture of the teacher was different from those of their learners. These teachers relied on the learners as a source of IK.

In the teaching of science lessons, the teachers are the knowledgeable experts and have subject content knowledge. The teachers were confident to teach science because of their educational qualifications and educational background. The learners on the other hand are the passive receivers of knowledge in the traditional South African science classrooms. However, in IK the knowledgeable experts are located in communities and traditional healers. Therefore, teachers have to access this IK, and then understand this IK before they can teach the IK to their learners. The lack of sufficient IKS knowledge by the teachers, as well as the fact that the teachers were largely dependent on their learners for IK, led to a lack of confidence by the teachers to teach IK to their learners. This study, together with other studies (Ogunniyi & Hewson, 2008; Ogunniyi & Ogawa, 2008; Ogunniyi, 2007 a, b) found that teachers did not possess adequate indigenous knowledge to confidently teach IK to their learners. This study showed further that, despite this inadequate indigenous knowledge, some teachers possessed the instructional skill to translate the IK brought by the learners, and implement this IK into the science curriculum.

Teachers are faced with the problems of worldviews that the learners bring to the classroom, and which provide explanations that are in conflict with Western science (Allan & Crawley, 1998). A finding of this study is that the worldview of the learner is not the only concern, and that the worldview that the teachers bring into the classroom will have implications for approaches that the teachers will take to include IK in their lessons. The approaches taken by the teachers in this study were significantly influenced by their education at school and university as well as beliefs and experiences at home whilst growing up. The teachers with a strong scientific worldview tend to focus on scientific explanations and incorporate IK into their lessons. On the other hand, those teachers who have a similar worldview or cultural background of the learners in their classroom tend to integrate IK and science. These teachers drew on the prior knowledge of the learners, which resulted in an increase in inputs from the learners. A finding emanating from this study is that, given teachers' background (i.e., cultural, political and social), teachers would implement IKS in different ways in the curriculum. However, the teachers who attended the workshop and were trained to integrate IK in the science

curriculum, were more confident because they have sufficient IK subject content knowledge and were less dependent on the learners for IK examples.

5.7 Recommendations

The present study revealed important findings (Chapter 4) which, if taken note of, have the potential of improving the implementation of the integration of IK and science by science teachers in the Western Cape Province. On the basis of these findings, a number of recommendations can be suggested for teachers, classroom practices, teacher education, teaching and policy. The recommendations arising from this study are therefore categorized under these categories below.

5.7.1 Teachers

Teachers teaching learners who hold a western perspective must be aware of the role of socio-cultural factors which influence science learning. According to Jegede and Okebukola (1991), the learners' socio-cultural backgrounds which they bring to the classroom may cause a pedagogical wedge between what the teacher teaches and what they learn. It is educationally unsound to present science education to non-western learners without careful consideration of the traditional mores and perceptions through which they are likely to interpret phenomena (Baker & Taylor, 1995). It is therefore recommended that teachers should be aware of the worldviews that the learners bring into the classroom may affect not only how they make sense of scientific information, but also to the extent to which they are willing to participate in the educational experience. Thus, teachers should make a concerted effort to identify those elements of the learners' culture which differ with the scientific culture, and to treat the elements of the learners' culture with the appropriate respect they deserve.

Traditionally the role of the teacher in curriculum change has been in executing the ideas of others such as policy-makers and curriculum designers. However, the role of the teacher in the reform process is of crucial importance. Any reform that seeks to by-pass

teachers, or to be overly prescriptive, will not succeed (Kirk & Macdonald, 2001). One of the reasons for the failure of *C2005* was the top-down approach in which the curriculum was implemented which seemed to underrate teachers' role in curriculum planning and implementation (Jansen & Christie, 1999; Jansen & Taylor, 2003). Schools and teachers should be given the freedom to plan and execute their own teaching. Teachers' commitment to, and ownership of, education change will grow, increasing the chances of a successful and enduring innovation (van Driel et al., 2007). It is recommended that, for successful implementation, partnerships should be formed between teachers, administrators, curriculum developers, professional associations and parents. This partnership is a fusion of the 'top-down' and 'bottom-up' strategies for reform in education, bringing a range of stakeholders who each have an interest in the nature of change in schools (Kirk & Macdonald, 2001). Teachers should be involved in all stages of the reform, and be involved in production of new syllabuses, members of advisory committees and participants in school-based trials of syllabus and curriculum materials. The contribution that teachers bring to the reform is their adaptation of the curriculum materials to fit their local context of implementation. The role of the teachers as partners in the reform process is derived from their intimate knowledge of their local context of implementation, in particular from their knowledge of their students, available resources, and the obdurate practicalities of their work (Kirk & Macdonald, 2001).

5.7.2 Policy

The guidelines for teaching from policy documents need to be clear and explicit. In the policy documents for Life Sciences and Natural Science only reference is made of IKS in LO3. Reference or implications of IKS is not sufficient to ensure that teachers would include IKS in their lessons. The policy document need to be clearly spelt out to ensure that teachers understand what is required of them and their learners. It is recommended that teachers should be given guidance and support in the policy documents on how to teach specific content, particularly in areas of difficulty, such as the integration of IK and science. Clarity on the appropriateness of certain instructional methodologies such as group work should also be provided. If teachers are provided with clear directions related

to the implementation of IKS in the classroom, then teachers should be able to develop a deeper understanding of the curriculum and pedagogy.

Because of a lack of guidelines from the policy documents, teachers were not in a position to evaluate the use and ideas of the new curriculum in effective ways. The Department of Education has acknowledged the weakness of a lack of guidelines and teachers have been more involved in the revision of the new policy document, the Curriculum Assessment and Policy Statement (CAPS). The CAPS document has been developed with input from all stakeholders and was implemented in 2012. To assess whether the policy document is implemented, it is recommended that mechanism to monitor implementation should be in place. This should start at district level where teachers are given the opportunity to express their opinion with regard to the policy. From the district level it should be discussed at Provincial level and then at National level. The Department of Education must utilise technology and create a website where teachers may express success or failures with regard to the implementation of the CAPS policy document. Across the Provinces teachers are willing to implement a new curriculum which may lead to an improvement in learner performances. However, the only problem teachers have is that they have no ‘voice’ and ownership in the development of policy. If their opinions are valued by the Department of Education, then they will embrace the new curriculum.

Teachers are willing to implement the new curriculum (Naidoo, 2005, 2010; Ogunniyi, 2009b). However, some factors such as availability textbooks and overcrowded classrooms were impeding their endeavours to do so. To make learning a productive activity, key resources such as textbooks should be supplied to the learners. Resources such as textbooks are a hindrance to successful integration of indigenous knowledge because they document “facts and truth” (Shizha, 2007: 314). Teachers usually accept what is written in the textbook as documented knowledge and thus do not deviate from what is presented as knowledge in textbooks. The Department of Education must recognise that there is not one indigenous culture that needs to be incorporated into education. The learners must be exposed to different cultural perspectives as part of their

history and heritage than ignoring diverse cultural perspectives. Therefore it is recommended that when textbooks with an indigenous content is written for the learners, it must be tackled locally from within the community because examples borrowed from other African cultures can be as oppressive as those borrowed from western countries such as Europe and America. It is not expected that outsiders who barely know the indigenous culture and languages to incorporate into textbooks African metaphor, folklore and stories.

Schooling in South Africa is geared towards learners passing the national Grade 12 examinations. With the introduction of IKS into the curriculum it was expected that LO3 must comprise 30% of the question paper. Many teachers argued that there were rarely explicit examples of IKS in the curriculum and for most of the time very little about IKS was assessed in the final Grade 12 examination (Diwu & Ogunniyi, 2011; Ogunniyi, 2007a). Thus, the teachers were discouraged from attempting to incorporate IKS in their science lessons. The importance with which examinations are viewed makes teaching stick to what is factual information and what is going to be tested in the final Grade 12 examinations. The examinations did not test IK or indigenous ways of knowing. Teachers are thus more concerned with their learners passing the final examination than with the integration of IK with science. The new CAPS policy document requires that Specific Aim 3 (LO3) will comprise only 10% of the final Grade 12 examination. This will demotivate teachers even further. It is recommended that the Department of Education must increase the Specific Aim 3 (LO3) content in the final Grade 12 examination to 30% to encourage teachers to teach IK and indigenous ways of knowing.

5.7.3 Professional development

What will happen when pre-service teachers (i.e., those teachers completing their undergraduate degree or the Post Graduate Certificate in Education certificate), eventually complete their training is influenced by what was taught at universities. According to Shizha (2007), when many teachers start teaching science after their studies, they lack an indigenous African perspective because they were not trained to

interpret science in a culturally sensitive manner. To disregard cultural fusion in the science program in teacher education denies teachers the skills and techniques for successfully incorporating IK in the formal science curriculum (Shizha, 2007). It is recommended that universities in South Africa should redesign their courses/modules in the undergraduate as well as post graduate teaching courses to include IKS. Universities should not only equip prospective teachers with IK, but also how to translate this knowledge into effective practice. Therefore, in the pre-service teachers' course practical approaches to teach IK should be built into the course. The universities should change their teacher education program so that the pre-service teachers are provided with experience in how to integrate IKS and science.

Many science teachers have only been exposed to Western science and were not exposed to any IKS training. These in-service teachers need opportunities to be re-trained in approaches to teach IK in their classrooms. Professional development and in-service training should be for teachers to become “actively engaged in meaningful discussion, planning and practice, particularly how the new curriculum materials and teaching methods will be used in the classroom (Garet, Porter, Desimone, Birman & Yoon, 2001: 925). According to these authors, this active learning would include opportunities to link ideas introduced during professional development experiences to the teaching contexts in which teachers work. These abilities cannot be developed through brief “one shot” in-service sessions traditionally regarded as professional development. It is recommended that science teachers should attend an IKS course for one or two terms (three to six months), expecting from them a commitment, to practice in their classrooms, the instructional approaches promoted by the program and evaluate the effectiveness of the teaching approaches in the context of their own teaching situation. After the training the teachers should be supported in their efforts. This support may be from peer teachers, senior staff members or curriculum advisors. All these stakeholders should have a shared vision which is critical for the success of the professional development. This may be followed up by one or two workshops or monthly get-togethers. In this manner successes or problems can be shared because all schools are not resourced the same.

Professional development must provide teachers assistance with the task of developing and teaching a culturally responsive science curriculum with the aim of bringing local knowledge to bear in the school curriculum. Teachers should be provided with instructional strategies that can help all science learners to negotiate border crossings between Western science and everyday local knowledge. This is also supported by Snively and Corsiglia (2001). Indigenous knowledge can be combined with various field of Western science (i.e., ecology, botany, biology, horticulture and medicine) to give the learners an enriched understanding of nature in line with sustainable communities and environments. This is also supported by Corsiglia and Snively (1995). The five-step model of Snively and Corsiglia (2001) can assist the learners to see the similarities as well as the differences between the IK and Western science, and to indicate where IK helps to fill the gap where knowledge in science is lacking and vice versa.

5.7.4 Teaching

Studies on cultural beliefs and science in Africa conclude that teaching and learning of science in school is not successful because the subject is not limited to everyday life experiences and the language of instruction alienates students (Clarke & Ramahlape, 1999; Dzama & Osborne, 1999; Shumba, 1999). Making science relevant to the lives of students require among a variety of other factors, a classroom environment in which students can be actively involved in making meaning of the information within a relevant real-life context. The teacher must be aware that learning is dependent on the learning environment as well as the existing knowledge of the learner, and learning will only be meaningful if the new knowledge fits into what the learner already knows. However, making science relevant to the everyday lives of children is a problem, but it may require a class environment in which learners can be actively involved in making the information meaningful. This study has shown that the atmosphere in the classrooms of those teachers, who started their lessons with IK, changed dramatically through the inclusion of the IK that the learners brought to the classroom and served as a catalyst in stimulating participation in teaching and learning of sciences. It is recommended that teachers need to learn to create an environment, and employ strategies which encourage active questioning

and identification of issues and answers by students. Teachers need to encourage their learners to challenge the information presented and discuss its personal relevance.

Science is usually presented in the ‘traditional’ manner, focusing on scientific concepts and skills without much attention for application in the learners’ daily lives (Van Driel et al., 2007). Indigenous knowledge is not a singular concept, and if IK is included in the science lessons, the fundamental diversity of IK must be taken into account such as local variations in language, knowledge, customs and traditions. Homogenous methodologies will thus not be helpful. It is recommended that many approaches to teaching science would be more suitable. Innovative instructional activities should be used such as inviting IK experts into class or taking the learners to them to learn firsthand how these IK experts work; learners need to argue, discuss and express themselves freely without feeling intimidated; and learners involved in problem-solving activities.

5.8 Significance of the study

The research on the topic indigenous knowledge and pedagogy is limited in depth and scope in the South African context. However, internationally there have been attempts made to include IK in the science curriculum. Studies including IKS as part of the curriculum focus on learners in some studies (Jegede, 1999a), on teachers in others, and on the curriculum in a few of the studies (Jegede & Aikenhead, 1999). This study is the first large-scale investigation in South Africa within the field of implementation of the integration of IK in the school science curriculum. This study successfully adapted and developed a valid and reliable instrument that can be used with confidence to establish the teachers’ understanding of IK, as well as the problems the teachers encounter in their implementation of the integration of IK and science in their classrooms.

In South Africa, studies of the implementation and the problems teachers encountered in the integration of IK and science have been conducted. However, these studies have focused on learners (i.e., Brown et al., 2006; Keane, 2008; Kyle & Kurz, 2006), or small-scale studies focusing on pre-service students or in-service teachers, which were students

of lecturers at South African universities (i.e., Naidoo, 2005; Ogunniyi, 2005, 2006; 2007a, b; Ogunniyi & Hewson, 2008; Onwu & Ogunniyi, 2006). This study is markedly different from other previous South African studies in that it focuses on practicing teachers in their classrooms and provides insights into particularly those individuals that will influence the implementation of the integration of IK in the science curriculum. This study has shown, at the chalkface, the difficulties and challenges teachers face, as well as the impact on the professional lives of science teachers when they have to implement a curriculum that is not readily available to them.

The policy document of the Department of Education (2002) acknowledges that there may be different worldviews present in the classrooms, as a result of rising diversity in South African classrooms. The worldviews of the learners are not all the same and may differ from the teacher's worldview. The policy document only assumes that "worldviews and indigenous knowledge systems is in its early stages and will be addressed with enthusiasm by many educators" (Department of Education, 2002: 12). This study has shown that the worldview of the teacher play an important role in the manner in which they approach the teaching of IK. In this study, those teachers that have a similar worldview than that of their learners, the teaching of IK is not a problem. However, if the worldview of the teacher and the learner is different, difficulties are encountered in the classrooms. Several studies (i.e., Allan & Crawley, 1998; Kawagley et al., 1998) have shown that a curriculum that is not sensitive to the learners' cultural background tends to produce passive learners. Ogunniyi et al. (1995) have argued that it is important for teachers to understand the learners' fundamental, culturally based beliefs so as to teach a kind of science that coincides with the socio-cultural setting of such learners.

When the new curriculum was introduced, one of the main criticisms was that teachers were not properly trained and not given the necessary support by the Department of Education. Thus, teachers had difficulty with the content and pedagogy of the new curriculum that was developed. This study has shown for curriculum reform to be successful, teachers should be involved in the conceptual and developmental stages so that they may take ownership of the reform process. Teachers should also be supported in

their efforts to apply and practice new teaching approaches demanded by the new curriculum through sustained professional development and not through brief “never to be repeated” in-service opportunities. This study provides insights of professional development of teachers in that it has shown that, by training teachers and supporting them, will result in an improvement in the teaching by science teachers.

Indigenous knowledge is not documented and is not readily available to teachers. Teachers have very little resource material to support them because the textbooks that are available to science teachers in South Africa did not include many cultural inclusions and activities (Naidoo, 2002). Teachers also do not necessary know the various indigenous knowledge systems that exists. This lack of indigenous material impedes the teachers’ implementation of the integration of indigenous knowledge in the science curriculum. Well-researched curriculum material was developed that was tested in workshops and this curriculum material has been made available to science teachers as well as their learners. The supply of the available resource material may also contribute to an improvement in the understanding of, and teaching of an indigenous curriculum in the science classrooms.

Moreover, this study provides insights regarding the implementation of the integration of indigenous knowledge in the science curriculum. This study has shown that in-service professional development is a central element of educational reform, and greater attention needs to be paid to what teachers think, feel and need in order to improve science instruction in their classrooms. It is hoped that the findings of this study on the role of teachers as curriculum implementers in educational reform will prove useful to teachers in South Africa and science teachers in the Western Cape Province in particular.

This study is the first large-scale investigation of its kind in South Africa within the field of the implementation of the integration of IK and science by teachers. This study successfully demonstrated that teachers can be trained to implement the integration of IK in the science curriculum using the five-step model of Snively and Corsiglia (2001). This

model provides a general framework for exploring the two perspectives (indigenous knowledge and Western science) whilst teaching about one concept or topic of interest. The class can be divided into small groups to research the two perspectives. According to Snively (1995: 68):

The introduction of aboriginal examples adds interest and excitement to the science classroom. All students need to identify and debate the strength and limitations of different approaches in order to explore how others experience the world, and broaden their understanding of the nature of science.

The situation described by Snively (1995) is similar to what the learners experienced in this study. When the teachers who were trained used the Snively and Corsiglia (2001) model, the learners enjoyed the lessons and the classes literally sprang to life when the teachers drew on the cultural background of the learner.

5.9 Recommendations for further research

The present study has provided additional research directions in the implementation of the integration of IK in the science curriculum. The section that follows will describe particular avenues for further research, as revealed by the findings of the present study.

First, research is needed to investigate teachers' views and attitudes towards learners' cultural background and towards proposed culturally sensitive instructional strategies, given the fact that the teachers themselves are also products of their cultural backgrounds. Furthermore, what effects will these attitudes, if present, have on the teaching/learning environment? According to the Department of Education (2002), several times a week learners cross from the culture of home, over the border, into the culture of science, and then back again. Research is needed to establish whether the teachers also practice border crossing as they teach.

Second, this study has revealed that teaching and modeling instructional approaches resulted in an improvement of the science teaching-learning process. However, the potential of the instructional approaches adopted in this study are worthy of closer

consideration in future research using larger samples and involving longer duration to provide a more holistic analysis of teachers' views on IK.

Third, the present study involved teachers from urban schools in the Western Cape Province and no teachers from rural environments. Thus, the focus on rural schools in the Western Cape Province may give insights how teachers in the rural schools implement the integration of IK in the science curriculum. Finally, the study could also be replicated in other provinces, especially poorer provinces like the Eastern Cape Province. These studies could provide a contrast between rich and poor provinces, and in addition how the teachers in the different provinces implement IK in the science curriculum.

5.10 Concluding summary

The primary object of the study was to establish what the high school science teachers' understanding of indigenous knowledge was and to establish whether teachers were implementing the integration of indigenous knowledge in the science curriculum as required by the Department of Education of Education. The study adapted and developed a questionnaire, the NOIKQ to assess the teachers' understanding of scientific and indigenous knowledge. The NOIKQ was administered to 370 practicing science teachers in the Western Cape Province.

The second objective was to describe the teachers understanding of indigenous knowledge and scientific knowledge in both quantitative and qualitative terms. Using the questionnaire as well as classroom observations and teacher and learner interviews, the study showed that the majority of the teachers in this study had a faulty notion about indigenous knowledge. The teachers' understanding and views of indigenous knowledge must be raised to levels which will enable them to operate effectively in the classroom.

The third objective was to provide indigenous resource materials to teachers and specific intervention which will yield a successful integration of indigenous knowledge in the science curriculum. Well-researched indigenous resource material was developed and

provided to teachers. A sample of teachers was trained in instructional strategies such as the five-step model of Snively and Corsiglia (2001) to integrate science and indigenous knowledge. An analysis of the classroom observations reveal that the teachers who were trained in integration of indigenous knowledge and science was more successful than those teachers who were not trained in such integration.

This study was conducted to establish whether high school science teachers are able to implement the integration of IK in the science curriculum. IK in the science classroom is a vibrant field of challenges, uncertainties and contradictions. The teaching of IK for many teachers is demanding because there is a lot of new learning involved. To enhance the prospect of success for all our learners, we need to ensure that all science teachers are supported in their pursuit of this new indigenous knowledge. This study has shown that the teachers who were trained to implement the integration of IK in the science curriculum using the Snively and Corsiglia (2001) model were more successful in the implementation than those teachers who did not use the Snively and Corsiglia (2001) model. The findings of this study have shown that in the classrooms of those teachers, who used the Snively and Corsiglia (2001) model, the learners were more active and more peer interactions were evident. It is hoped that this study has given a better understanding of the hindrances and challenges teachers face as they implement indigenous knowledge in the classrooms, and will boost the teachers' ability and confidence in the teaching of science. Furthermore, it is hoped that this study contributes to the improvement of science education provided to all learners in South African schools.

3 Jangada Street
Sun Valley
Fish Hoek
22 March 2006

For Attention: Dr. Cornellissen
The Research Directorate
WCED
Private Bag X9144
Cape Town

Dear Sir

REQUEST: PERMISSION TO CONDUCT RESEARCH AT SCHOOLS

I have registered at UCT for a PhD in Science Education this year. At present I am still writing my research proposal, which must be completed by the end of September.

My area of interest is indigenous knowledge systems (IKS). The Department of Education has included IKS and different world views in the Science Curriculum. However, many problems are foreseen with the implementation of IKS in the Science Curriculum.

The aim of my research is to establish the problems that the educators encounter in the integration of scientific and indigenous knowledge systems.

I intend to develop a questionnaire which must be completed by the educators. I do not have specific institutions where the research will be conducted but wish to include most of the schools (Primary and Secondary) in the Western Cape. In this manner I hope to collect data from as large a group as possible so that my results can be generalisable. The time frame for gathering the data will be from May to November.

All the necessary documents will be forwarded i.e. approved proposal, measuring instruments, etc. as soon as they are completed. All that I require at the moment is approval from the Department so that I can start contacting the schools as soon as possible. All results obtained from this research will be forwarded to the WCED to be utilized in a manner suited for them.

I can be contacted at 084 207 7154 for further information.

Thanking you.

Yours faithfully

K. R. Jacobs

Námaro
Fonqineer
Rebuzo
Telatlon
Telephons
Ibani
Faks
Fao
Ibeka

Dr RS Cornelissen

(021) 467-2286

(021) 425-7445



Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Verwysing
Reference
Bekibini

20060413-0029

Mr K.R. Jacobs
3 Jangada Street
Sun Valley
FISH HOEK
7975

Dear Mr K.R. Jacobs

RESEARCH PROPOSAL: TO ESTABLISH THE PROBLEMS EDUCATORS ENCOUNTER IN THE INTERGRATION OF SCIENTIFIC AND INDIGENOUS KNOWLEDGE SYSTEMS.


Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **1st February 2007 to 22nd September 2007.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December 2007).
7. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the Principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as submitted to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Education Research.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Education Research
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000**

We wish you success in your research.

Kind regards,


for **HEAD: EDUCATION**
DATE: 23rd January 2007

MELE ASSENLIEF VERWYSINGSNUMMERS IN ALLE KORRESPONDENSIE! PLEASE QUOTE REFERENCE NUMBERS IN ALL CORRESPONDENCE!
KELEA URBALU HONWOLU ZESALATHISO KUYU YONKE IMBAGLLAWANO

GRAND CENTRAL TOWERS, LAER-PARLEMENTSTRAAT, PRIVAATSAK X9114, KAAPSTAD 8000
GRAND CENTRAL TOWERS, LOWER PARLIAMENT STREET, PRIVATE BAG X9114, CAPE TOWN 8000

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VELIGE SKOLESAFE.SCHOOLS ☎ 0800 45 46 47

3 Jangada Street

Sun Valley

28 March 2007

Dear Colleagues

I am an educator who is at present registered at University of Cape Town for a PhD in Science Education.

I am conducting research with regard to indigenous knowledge systems (IKS). The Department of Education has included IKS and different world views in the Science Curriculum. However, many problems are foreseen with the implementation of IKS in the Science Curriculum.

The purpose of my research is to establish the problems that the educators encounter in the integration of scientific and indigenous/ traditional knowledge systems and to inform the Education Department. The Western Cape Education Department has approved the research at schools (see attached letter). I would appreciate it if Natural Science as well as Life Science (Biology) could please complete the questionnaire.

I am aware that educators have a heavy workload and do not have time to fill in questionnaires. I would appreciate it if the educators could complete the questionnaire and it will not take more than 20 minutes to complete.

The completed questionnaire must be returned to the head of department/ educator designated by the principal. The completed questionnaires will be collected by the researcher / or to be posted (use self-addressed envelope).

I can be contacted at 0842077154 or 021- 7853865 (after 18:00)

Thanking you.

Keith Jacobs

CONSENT FORM

I hereby agree to participate in the research regarding the **INTEGRATION OF INDIGENOUS KNOWLEDGE IN THE SCIENCE CLASSROOM**. I understand that I am participating freely and without compulsion. I also understand that I can stop this interview at any point, should I choose not to continue. The decision to discontinue my participation will not affect me negatively.

The purpose of the study has been explained to me, and I understand what is expected of my participation. I understand that this is a research study, and the purpose of the research may not benefit me personally.

I have received the telephone numbers of a person to consult, should I need to speak about any issues that may develop from the interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential. I understand that, if at all possible, feedback will be given on the results of the completed research.

Signature of participant:

Date:

In addition to the above, I hereby agree to the audio recording of the interview, as well as video recording of the classroom observation, for the purpose of data capture. I understand that no personally identifying information or recording concerning me will be released in any form. I understand that these recordings will be kept in a secure environment, and will be destroyed or erased once the data capture and analysis has been completed.

Signature of participant:

Date:

SURVEY OF NATURE OF INDIGENOUS KNOWLEDGE OF EDUCATORS

Welcome to the **Nature of Indigenous Knowledge** survey. I appreciate your participation and hope that this survey is interesting for you.

South Africa is characterized by multicultural classrooms. One of the Learning Outcomes of the Revised National Curriculum Statements for Natural Science and the National Curriculum Statements for Life Sciences is that Science Education should help learners to acquire scientific and indigenous knowledge which will enable them to solve practical problems within and outside the science class.

Your participation is important in this survey, because I am trying to establish the problems teachers encounter with the understanding and implementation of indigenous knowledge systems. **All your answers to these questions are completely confidential.** Only the researcher from the University of Cape Town will have access to your original responses and no individual respondent to this survey will ever be identified in any report based on this survey.

To protect your privacy, please do not place your name on any part of this survey. Please fill in the questionnaire and answer the questions as honestly as you can. There is no right or wrong answers. **It should take you about 30 minutes to complete this survey.**

If you are interested in a forthcoming workshop I will be pleased to present the overall findings obtained from several hundred science educators like yourself.

Thank you for your co-operation.

If you have any questions about this survey, feel free to contact Keith Jacobs on 0842077154 or 021-7853865 after 18:00.

PART A – YOUR BACKGROUND

For each of the following questions, make a mark in only one box for the answer.

A1	What is your gender? 1= Male 2= Female	<input type="checkbox"/> 1 <input type="checkbox"/> 2
A2	To which population group do you belong? 1= Black African 2= Coloured 3= Indian or Asian 4= White	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
A3	Which language do you speak most often at home? 1= Afrikaans 2= English 3= IsiXhosa 4= IsiZulu	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
A4	To which qualification category do you belong? 1= No Matric, No training 2= Matric with no training/ REQV10 3= Standard 6,7,8,9 + 2years training/ REQV11 4= Matric + 1 or 2 years training/ REQV12 5= Matric + 3 years training / REQV13 6= Matric + 4 years training / REQV14 7= Matric + 5 years training / REQV15 8= Matric + 6 years training/ REQV16	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8
A5	To which religious group do you belong? 1= Christian 2= Muslim 3= Hindu 4= Jewish	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
A6	Learning area being taught this year 1= Natural Science 2= Life Sciences / Biology	<input type="checkbox"/> 1 <input type="checkbox"/> 2
A7	How long have you been teaching? 1= Less than 1 year 2= 1 – 5 years 3= 6 – 10 years 4= More than 10 years	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
A8	At what type of school are you teaching? 1= Primary school 2= High school	<input type="checkbox"/> 1 <input type="checkbox"/> 2

Instructions: Answer the following questions as honestly and as fully as you can. There is no right or wrong answers to any of the questions. Please carefully read all questions and write your answers in the spaces provided. Use **examples** to explain/ defend each of your answers.

PART B

Question B1

After scientists have developed a theory (e.g. atomic theory, cell theory, membrane theory), the theory may or may not change. Do you think this is applicable to indigenous knowledge systems? YES ☐ NO ☐

Motivate your answer

Question B2

What, in your view, is 'scientific' knowledge?

Example:

Question B3

What, in your view, is 'indigenous' knowledge?

Example:

Question B4

In your view, what distinguishes ‘scientific’ knowledge from ‘indigenous’ knowledge?

Example:

Question B5

What, in your view, do ‘scientific’ knowledge and ‘indigenous’ knowledge have in common?

Example:

Question B6

How do you personally “bridge” the two worlds of ‘scientific knowledge’ and ‘indigenous knowledge’ in the classroom?

Example:

Question B7

Do your learners show any evidence of understanding the relationship between their home cultures and the science you teach in class? YES ☐ NO ☐

If YES, give one example

PART C

Question C1

Tick off the claims or statements in the table below which you think apply to science knowledge systems, to indigenous knowledge systems (IKS), or to both.

Item	Statement/claim	Science	IKS	Both
1.	Space is real and has definite dimensions.			
2.	A Supreme being created and controls the universe.			
3.	Space is real and has definite and indefinite dimensions.			
4.	Time is real and has a continuous series of durations that are irreversible.			
5.	Matter is real and exists within time, space and the spiritual realm.			
6.	Sensory perceptions are not the only means of understanding nature.			
7.	Nature is real, observable and testable.			
8.	All events have natural causes only.			
9.	Language is an important tool that can be used to explain, predict and even create natural phenomena.			
10.	Sense perceptions are the only valid and reliable means to understand nature.			
11.	Nature is real, partly observable and partly unobservable.			
12.	The universe is orderly, partly predictable and partly unpredictable.			
13.	Language is an important tool that can be used to describe and to explain, but not to create natural phenomena.			
14.	It is highly probable that the universe occurred by chance and therefore undergoes continuous evolution.			
15.	Humans are capable of understanding only part of nature.			
16.	Time is real, continuous and cyclical.			
17.	Events have both natural and unnatural causes.			
18.	Humans should live in harmony with nature rather than to exploit nature.			

Question C2

Which of the following instructional methods do you consider to be critical for integrating the teaching of science and indigenous knowledge systems (IKS)?

Rank the instructional methods for integrating science and IKS in the 3rd column from the most important =1 to the least important =11.

Item	Instructional method for integrating science and indigenous knowledge	Rank
1.	Frequent use of provocative, argumentative or inquiry-based questions.	
2.	Using a holistic or an integrated instructional approach.	
3.	Emphasizing 'showing' or modelling rather than lecturing.	
4.	Involving learners actively in problem-solving activities.	
5.	Developing or extending lessons to include current issues such as HIV/AIDS, genetic engineering, drugs and sports, cloning, etc.	
6.	Starting lessons with learners' ideas before presenting the scientific view.	
7.	Extending science classroom discussions to include the IKS modes of inquiry, e.g. inviting IKS experts into class on some topics.	
8.	Avoid presenting indigenous knowledge as primitive science that is under development.	
9.	Reject the claim that science works in the physical world while indigenous knowledge is only concerned with the social and spiritual worlds.	
10.	Assess each knowledge claim with its own assumptions and standards rather than using science to judge indigenous knowledge as true or false.	
11.	Emphasize cooperative learning rather than competitive learning.	

PART D

Question D1

Have you had any training/ workshops on Indigenous Knowledge Systems?

YES ☐

NO ☐

Question D2

If you had any training, have you tried any of the activities in class?

YES ☐

NO ☐

If yes, what was the result?

Question D3

Are the currently available textbooks useful in assisting you in the implementation of Learning Outcome 3 in the class room? Motivate your answer.

Question D4

Do you include Learning Outcome 3 when you teach? YES ☐

NO ☐

If Yes, give ONE example

Question D5

Do you teach multicultural classes? YES

☐

NO

☐

If Yes, do you consider that they may have different worldviews? Explain.

Question D6

What problems do you face in implementing the integration of scientific and indigenous knowledge systems in your classroom lessons?

Question D7

What workshops/advisory/resource assistance do you need to implement Learning Outcome 3?

Thank you for participating in this survey.

3 Jangada Street
Sun Valley
25 May 2007

Dear Colleagues

I am an educator who is at present registered at University of Cape Town for a PhD in Science Education.

I am conducting research with regards to indigenous knowledge systems (IKS). The Department of Education has included IKS and different world views in the Science Curriculum. However, many problems are foreseen with the implementation of IKS in the Science Curriculum.

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I can be contacted at 0842077154 or 021- 7853865 (after 18:00)

Thanking you.

Keith Jacobs

WESTERN SCIENTIFIC KNOWLEDGE VS/AND INDIGENOUS KNOWLEDGE SYSTEMS

Purpose of this workshop:

- to introduce different concepts e.g. indigenous knowledge, Western science etc.,
- to develop understanding of various concepts through a series of activities,
- to provide suggestions and models according to which integration of IKS and WSK can occur, and
- to provide educators with resource material for use in the classroom.

Introduction

There are many different ways of looking at the interrelationships between humans and their surroundings. The perspective of the Western (or Northern) world is often the dominant one in education. It is important that other experiences of the environment and human relationships with the environment are appreciated and valued.

Indigenous knowledge is the local knowledge of a culture or society. It is also known as local knowledge, folk knowledge, people's knowledge, traditional wisdom or traditional science, and is usually unique to and characteristic of the specific culture or society.

It is important to realise that indigenous knowledge is constructed from generation to generation, by word of mouth and cultural rituals. It has been the basis for agriculture, food preparation, health care, education, and conservation, as well as a wide range of other activities. It is these activities that sustained societies and their environments for many centuries.

Indigenous people have a wide knowledge of the ecosystems in which they live, and of using natural resources sustainably. However, where colonial (Western) education systems replaced the practical aspects of indigenous ways, abstract academic learning puts indigenous knowledge at risk. Much indigenous knowledge about ways of living sustainably, ecologically as well as socially, is being lost.

Indigenous knowledge may be integrated into the curriculum in many ways, bringing the benefits of: saving indigenous knowledge, gaining respect for local culture, wisdom and ethics, learning locally relevant knowledge and skills, as well as rethinking the Western perspective in education.

(based on Draft Module (IKS) by Annette Gough)

Activity 1

Let's discuss the concepts of western scientific knowledge and indigenous knowledge systems.

For discussion in smaller groups:

20 minutes

1. What does the term "Western Scientific Knowledge" imply?

2. What is meant by the term "Indigenous Knowledge Systems"?

3. Why western/modern knowledge systems are immediately connected with scientific thought, while indigenous systems are quite often not?

4. What is meant by "scientific" knowledge? (Think of the scientific method.)

5. What is meant by "indigenous" knowledge? How did it originate?

6. Is any one of these two concepts "better" or "worse" than the other? Explain your answer.

7. Do you have any example of indigenous knowledge from your own home/family?

Give feedback in the larger group. Discuss questions/ issues that arose from questions and answers.

Activity 2

Who are Indigenous People?

For discussion in small groups

20 minutes

According to the International Labour Organisation, there are about 5 000 different indigenous or tribal people living in 70 countries. The total world population is estimated at about 250 – 300 million people, mostly in Asia.

Definition 1

The UN defines Indigenous and Tribal people as follows:

- Tribal people in independent countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations;
- People in independent countries who are regarded as indigenous on account of their descent from the populations which inhabited the country, or geographical region to which the country belongs, at the time of conquest or colonisation or the establishment of present state boundaries and who irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions.

Alan R Emery and Associates (1997)

Definition 2

Indigenous people are strikingly diverse in their culture, religion, and social and economic organisation. Yet, today as in the past they are prey to stereotyping by the outside world. By some they are idealised as the embodiment of spiritual values; by others they are denigrated as an obstacle to economic progress. However, they are people who cherish their own distinct cultures, are the victims of past and present-day colonialism, and are determined to survive. Some live according to their traditions; some receive welfare; others work in factories,

offices or the professions. As well as their diversity, there are some shared values and experiences among indigenous cultures. Where they have maintained a close living relationship to the land, there exists a cooperative attitude of give and take, a respect for the Earth and the life it supports, and a perception that humanity is but one of many species.

J Burger (1990)

Questions

1. Which definition do you prefer? Why?
2. Why are “legal” ideas in definition 1 important?
3. Which groups in South Africa could be classed as “indigenous” according to definition 1?
4. Why are the “subjective” ideas in definition 2 important?
5. Which groups in South Africa could be classed as “indigenous” according to definition 2?
6. Write your own working definition of “indigenous people”.

Sources: Alan R Emery & Associates, Guidelines for Environmental Assessments and Traditional Knowledge (1997) and J Burger, Gaia Atlas of First Peoples: A Future for the Indigenous World (1990).

Activity 3

Comparison between indigenous and scientific knowledge

Individual activity

10 minutes

Study the aspects of knowledge column and decide which of the marked statements belong to indigenous knowledge, and which to scientific knowledge:

ASPECT OF KNOWLEDGE	STATEMENTS	INDIGENOUS KNOWLEDGE	SCIENTIFIC KNOWLEDGE
Scope	A: sacred and secular B: secular only C: holistic D: analytical, based on sub-sets E: stored in books and computers F: stored orally and in cultural practices		
Truth Status	A: assumed to be the truth B: assumed to be a best approximation of truth C: truth found in faith and nature D: truth found in human reasoning E: explanations based on examples and experience F: explanations based on hypotheses, theories and laws		
Purpose	A: long-term wisdom B: survival and practical life C: ecological validity D: short-term prediction E: abstract F: powerful predictability in natural principles		
Methods of teaching and learning	A: rapid B: formal education C: learning by living, experiencing and doing D: tested in practical situations E: teaching through examples and rituals F: tested artificially in examinations		

Adapted from Alan, R Emery et al. Guidelines for Environmental Assessments and Traditional knowledge (1997).

The table above might give the idea that IKS is “less important, less valuable, less useful and less truthful” than Western modern science. Why then, is it

necessary to study indigenous knowledge? The following activity should help to clarify this issue:

Activity 4

The importance of indigenous knowledge

Discussion in small groups

20 minutes

Read the following paragraphs that form an essay written by Maurice Strong. The paragraphs are mixed. Arrange them in the correct order.

After the paragraphs have been put in the correct order, reread the essay and do the following:

- *Identify three reasons why Maurice Strong believes that indigenous knowledge is important.*
 - *Insert these three reasons as sub-headings at appropriate places in the completed essay.*
-
- A.** Our material progress is achieved at the cost of passing on a wasteland to our children. As this turbulent century closes, we must alter radically our ways of life, patterns of consumption, systems of values, even the manner in which we organise our societies, if we are to ensure survival of the Earth, and ourselves.
 - B.** What modern civilisation has gained in knowledge, it has perhaps lost in wisdom. The indigenous peoples of the world retain our collective evolutionary experience and insights which have slipped our grasp.
 - C.** While no-one would suggest that the remainder of the more than 5 billion people on our planet would live at the level of indigenous societies, it is equally clear that we cannot pursue our present course of development. Nor can we rely on technology to provide an easy answer.
 - D.** They have protested and resisted. Their call is for control over their own lives, the space to live and the freedom to live in their own ways. And it is a call not merely to save their own territories, but the Earth itself.
 - E.** Yet these hold critical lessons for our future. Indigenous peoples are thus indispensable partners as we try to make a successful transition to a more secure and sustainable future on our precious planet.
 - F.** Indigenous peoples have evolved over many centuries a judicious balance between their needs and those of nature. The notion of sustainability, now recognised as the framework for our future development, is an integral part of most indigenous cultures.

- G. Our Earth is a vulnerable, abused place. Its opulent forests are rapaciously felled, its rivers and oceans polluted, its already degraded soils worked lifeless, its delicate envelope of atmosphere - the very basis for life on this planet – is contaminated. In bending nature to our implacable will, we are also destroying her.
- H. As we reawaken our consciousness that humankind and the rest of nature are inseparably linked, we will need to look to the world's more than 25 million indigenous peoples. They are the guardians of the extensive and fragile ecosystems that are vital to the wellbeing of the planet.
- I. In the last decades, indigenous peoples have suffered from the consequences of some of the most destructive aspects of our development. They have been separated from their traditional lands and ways of lives, deprived of their means of livelihood, and forced to fit into societies in which they felt like aliens.

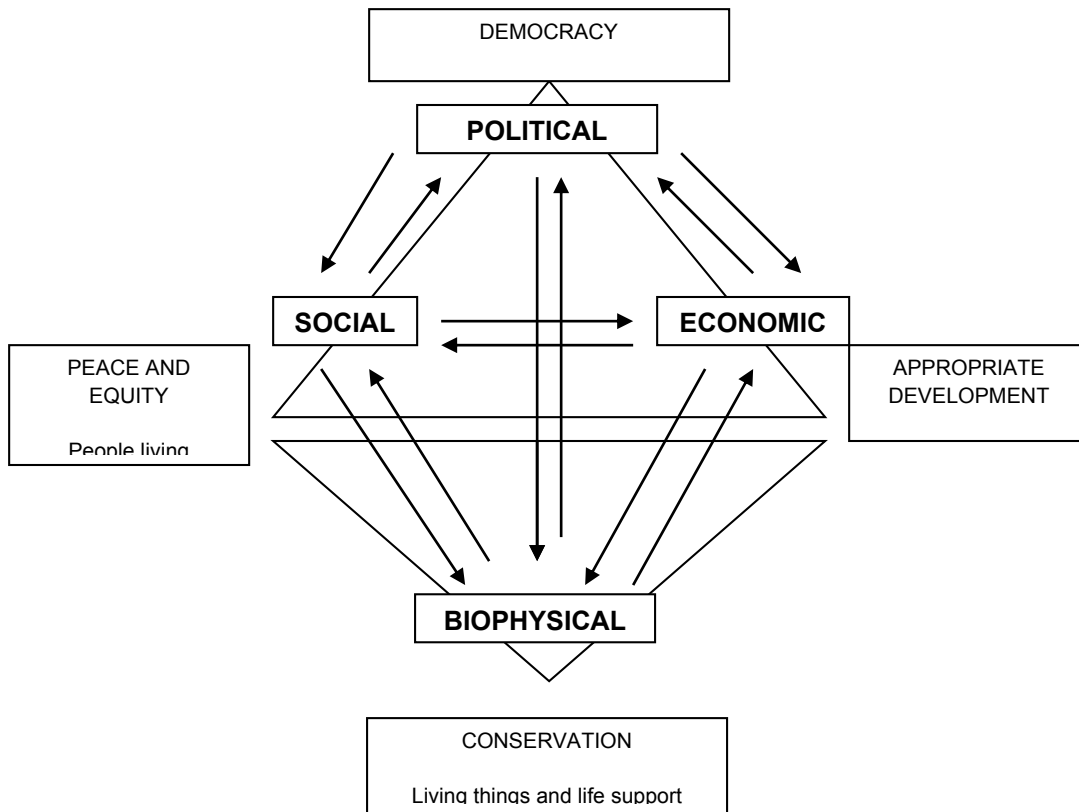
Original essay by Maurice Strong, key organiser of the Earth Summit in Rio de Janeiro in 1992. The essay was written as a foreword to the Gaia Atlas of First peoples (Burger 1990).

Integration of IKS into the curriculum

There are many ways in which IKS can be integrated into the curriculum; environmental studies/ life sciences are especially suitable for this purpose.

The following model should be kept in mind when discussing the environment. The diagram illustrates the four systems of the environment: social, political, economic and biophysical, as well as the values underlying a sustainable environment. It is important to realise that none of the systems/ values depicted in the diagram can stand alone and independent from the others. A shift in the economic balance of a community, for example, will ultimately bring about certain changes in the social, political and biophysical aspects of that community.

When teaching indigenous knowledge as part of the school curriculum, the interdependency of these systems and values should be kept in mind.



Source: R O'Donague, Natal Parks Board, South Africa

Two models for the teaching of IKS as part of the curriculum exist:

- Coexistence
- Integration

The integration model has two alternative approaches:

1. IKS → Western Science where IKS is studied/ investigated and then linked to Western modern science or ...
2. IKS ↔ Western Science where IKS is studied as part of and integral to knowledge in Western modern science.

In applying the integration model as a tool for teaching the following steps can be followed:

- Choose a concept from the curriculum.
- Identify personal knowledge/ beliefs etc.
- Research the various perspectives of IKS and WKS with regards to similarities and differences.
- Reflect on the consequences of each perspective; build consensus.
- Evaluate the process.

With coexistence as a model for teaching the values, contents and outcomes of the different knowledge systems exist on a comparable level.

Important: Both models are based on constructivism, i.e. prior knowledge of the learner is important.

IKS can be categorised according to the following classification (George 1999) for use in the classroom:

- **Category 1:** cultural knowledge can be explained in terms of Western science, e.g. the practice of using lime juice and salt to remove rust stains from clothes can be explained in conventional scientific terms of salt/oxide/ acid reactions.
- **Category 2:** a conventional scientific explanation for cultural knowledge seems likely, but is not yet available.
- **Category 3:** a conventional science link can be established, but the underlying principles are different e.g. cultural knowledge states that sugar causes diabetes while modern science claims then when one is diabetic, sugar can worsen the condition.
- **Category 4:** the cultural knowledge cannot be explained in conventional scientific terms e.g. there is no scientific explanation for the belief that hair will grow faster when cut in the moonlight!

Activity 5

Case studies as examples of indigenous knowledge in everyday situations.

Discussion in small groups

20 minutes

Study the following reading passages:

1. Daniel has a sore tooth. His grandmother, on a visit from Beaufort West, tells his mother to heat coarse salt, put it in a cloth and hold it against his cheek. She says the pain will go away soon.
2. Sipho has a bad summer cold. His mother does not think it is necessary to take him to a doctor. She remembers that when she was a girl, her mother used to give her a dessert spoon of brandy followed by a teaspoonful of honey and lemon juice every few hours. She does the same for Sipho.

3. Little Elizabeth has been crying with colic since late last night. Her mother is young and inexperienced and goes to the neighbour to ask her advice. The neighbour, Mrs. Tshali, recommends putting a few sprigs of the wormwood plant in a muslin bag, hanging it around the baby's neck on a piece of string so that the wormwood bag touches the baby's tummy.

Questions for discussion:

15 minutes

1. Which of the remedies, do you think, might help for the specific ailment?

2. Which of the remedies will not help? Why? _____

3. Can you think what the belief/reasoning behind each of the remedies is?

4. Discuss each of the remedies to see if there is any scientific basis for the specific remedy. Explain.

5. Which of the remedies, in your opinion, has no scientific basis? Explain why you chose this remedy.

6. Which of the remedies might be dangerous/harmful to the sufferer? Why?

7. One of the remedies above can be replaced by “over-the-counter” medication from the pharmacy. Can you think which? Suggest what can be bought from the pharmacy.

8. Classify the remedies according to the four categories of indigenous knowledge:

INDIGENOUS REMEDY	Category 1, 3 or 4
Heated salt	
Brandy, honey and lemon juice	
Wormwood in muslin bag	

Indigenous knowledge systems from around the world

Indigenous knowledge and practices vary greatly between countries and regions. The activities and resources here may need to be **supplemented with local ideas** and materials. Facilitators may find it useful to approach local indigenous groups, libraries and interested colleagues to arrange local perspectives on indigenous knowledge.

Another important aspect to keep in mind is the place of **IKS in the national curriculum** (NCS).

Storytelling was (is) the most common way in which indigenous knowledge was transmitted. Contact a local storyteller or elder of the community with stories to tell.

Activities should be **adapted according to the requirements of the NCS** and phase of teaching i.e. **GET or FET**, and the grade involved.

The **depth of teaching and the amount of time** allocated to the topic will depend on the educator's interests and ability to teach IKS, as well as the needs of the learners as well as the availability of resources.

The following activity can be used as an in-depth study of IKS from various parts of the world:

Activity 6

Indigenous knowledge systems from around the world.

Activities in various groupings

1 hour

1. The Maasai of East Africa:

The Maasai are cattle herding pastoralists. About a million of them inhabit the semi-arid lands of Kenya and Tanzania in an area bordered by Mount Kilimanjaro in the east, the Serengeti Plain in the west, and the Ngorongoro Crater in the south. The Maasai are well known for their independent ways, fitness and skill with weapons.

Cattle are the basis of the Maasai economy, providing food mainly in the form of milk and meat. Up to 66% of the calories consumed by the Maasai come from fat, mainly saturated fats. This results in a daily intake of more than 2 000 milligrams of cholesterol.

Dieticians recommend that fats provide no more than 30% of the calories in a typical Western diet. Yet, the Maasai have mean serum cholesterol levels in the normal to low range.

According to Dr. Timothy Johns from the McGill University (Canada) this could be attributed to the following reasons:

1. The Maasai's high fitness level
2. Unknown genetic factors
3. A high calcium intake
4. A relatively low calorie intake
5. Substances found in traditional plant products

So far, 25 plant products used by the Maasai have been identified. Some of them are:

1. Latex (a milky substance used to form rubbery material) from the Ficus tree.
2. Roots and barks from various plants chewed to alleviate thirst (chew sticks, some of them gum-producing).
3. A species related to the myrrh plant, producing a plant gum, has hypopolipidemic properties (reduces serum cholesterol).
4. *Acacia nilotica* is a source of anti-oxidants. The bark is used to flavour meat soups and milk. Various acacia extracts have stronger antioxidant properties than either vitamin E or C – the most popular antioxidants sold in western countries.

The plants used by the Maasai have tremendous potential for development. Northern Americans are almost obsessed with antioxidants, and in most First World or even developing countries increasing cholesterol counts are the reason for a high incidence of heart and vascular diseases.

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2. The village of Barali Kass in Kashmir, Pakistan.

The village of Barali Kass is situated about 20 km from the district head quarters of Kotli. The altitude of the area ranges from 740 m to 1200 m. It is included in the subtropical zone.

Temperatures are very hot in summer and cool in winter. June and July are the hottest, while December and January are the coldest months. The north-eastern to south-western winds blow strongly especially in the mornings and evenings. The average rainfall of the area is 114, 4 mm p.a. The area has a relatively high humidity ranging from 77% to 57%.

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Medicinal plants are widely employed by healers for the treatment of a variety of ailments and chronic diseases and disorders. At this stage about 66 plants are known to be used.

The present population has little knowledge about the medicinal plants of the area, but some knowledge is still passed on orally from one generation to the next.

Some of the medicinal plants used are:

Botanical names and common names	Indigenous medicinal uses
<i>Amaranthus spinosus</i> Surkh, Ganar	The root of the plant is diuretic. The leaves are eaten as a vegetable.
<i>Amaranthus viridis</i> Safed, Ganar	Leaves are laxative and diuretic.
<i>Nerium oleander</i> Gandeera	Extracted oil from the bark is used to destroy maggots infesting wounds.
<i>Cannabis sativa</i> Phang	Decoction of the leaves is used for stomach ache; useful in leprosy. Dried and crushed leaves taken as narcotic drink.
<i>Euphorbia hirta</i> Moti, Dodal	Juice of the plant is given for dysentery and colic. Milk obtained from the plant is applied to remove warts.
<i>Menta longifolia</i> Chita, Poodina	Herbal tea is taken for abdominal disorder.
<i>Salvia officinalis</i> Noorchari	Decoction of leaves is used to treat cough, cold and sore throat. The root paste is very useful in scorpion sting and snake bite.
<i>Allium sativum</i> Thoom	Bulb is carminative, stimulant, aphrodisiac and expectorant. Also useful in fever, high blood pressure and respiratory problems.
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<i>Myrsine africana</i> Googal	Fruit given to expel tapeworm from intestines.

Acknowledgement: Ejaz Ur-Rehman, Department of Botany, University of Azad jammu and Kashmir, Pakistan.

3. The people living in the Himalayas of Uttar Pradesh

The Himalayas are divided into two administrative regions: Kumaon where the *Kumaoni* dialect is spoken and Garhwal where *Garhwali* is spoken.

The same plants grow in the two regions, but the names and uses differ. For example, *Urtica dioeca* (stinging nettle) in Garhwal is known as “*kaldiya*” and not used for anything, while in Kumaon the plant is known as “*shisoona*” and used by the local people for relieving rheumatic pains. It is either applied topically, or the leaves are eaten as a vegetable.

The people of Kumaon also cultivate the Soya bean (*Glycine soya*). It forms an important part of their diet as a plant protein. The people of Garhwal neither cultivate nor eat the Soya bean. Soya bean are very rich in protein, on a par with meat, and can help to correct the protein deficiency kwashiorkor.

Efforts to raise awareness regarding the uses of naturally growing local plants are based on the fact that people will be drawn to interesting information about plants they are familiar with. Exhibitions of useful local plants are held in various meeting places: government community services, block development offices, tea stalls and village fairs. When the people of Garhwal visit towns in Kumaon they are told about the useful plants of the area, plants also found in Garhwal.

The natural vegetation of Kumaon is, as in many other places, under threat from collecting in the wild. People also have to be taught about the medicinal uses of plants growing in the area of which they are not aware in order to promote cultivation of these plants. Indigenous knowledge therefore needs to be supplemented. This will lead to a sustainable use of plants for their own needs as well as for selling to buyers in the city.

One scheme that has already been implemented with success is the soapnut. Local people use the soapnut to wash their hands, hair and clothes, and have always collected it from the forests. They are now given soapnut tree seedlings to plant near their huts. They no longer have to collect it from the forests and have enough left to sell to urban manufacturers of shampoo.

Acknowledgement: Dr NC Shah, Centre for Indigenous Knowledge of Indian Herbal Resources, India.

4. Our own heritage: Indigenous knowledge in South Africa

Healers in South Africa use a variety of indigenous plants. It is estimated that 70% of South Africans consult traditional healers. Many of the traditional medicines used in South Africa are still derived from plants. Large quantities of plants and their extracts are sold in the informal sector. Some of the plants used by traditional healers are:

Botanical names and common names	Indigenous medicinal uses
<i>Agathosma betulina</i> Ibuchu (Xhosa), boegoe (Afr.), bucchu (Khoisan, Eng.)	Leaves and roots are used. Treatment of kidney and urinary tract diseases. Applied locally to bruises and rheumatic pains. Leaves chewed for stomach complaints. Infusions used against fever, tiredness and congestion of chest.
<i>Aloe ferox</i> Ikhala (Xhosa), bitteraalwyn (Afr.), Cape aloe (Eng.)	Mainly leaves are used. Fresh leaf juice used to treat conjunctivitis. Powder from charred leaves for venereal sores. Ground leaves used for snuff. Traditionally used to treat arthritis, eczema and hypertension. Applied externally to treat skin irritations, burns and bruises.
<i>Artemisia affra</i> Umhlonyane (Xhosa, Zulu), wildeals (Afr.), African wormwood Eng.)	Highly aromatic leaves used as tea for stomach complaints. Crushed leaves commonly inhaled for headaches and colds. Treatment of measles and malaria. Powders in milk or water used as enemas, against intestinal worms.
<i>Salix mucronata</i> Umngcunube (Xhosa), wilde wilger (Afr.), wild willow (Eng.)	Branch tips and leaves are used. Against rheumatism and ever. Plant has anti-inflammatory properties. Aspirin, the analgesic, derived from this plant.

The leaves and roots of edible plants can have an important nutritional value in the rural areas where malnutrition often occurs. With urbanisation however, there is a movement away from traditional crops and more Western eating habits are developing.

Some of the indigenous food types such as rooibos tea (*Aspalathus linearis*) and honeybush tea (*Cyclopia* spp.) have developed as an agricultural industry with export potential. Bucchu, one of the traditional medicinal plants, is exported in large volumes. This however, is not for medicinal uses but mainly as a fixative in the food industry. Bucchu is also used on a small scale in the ornamental industry. Only aloe and devil's claw (*Harpagophytum procumbens*) are exported for medicinal use.

Acknowledgement: Iziko South African Museum: ulwazi lwemvelo – indigenous knowledge in South Africa.

Questions for discussion

1. Divide the class into four expert groups. These groups must each discuss one of the above countries (Maasai from Kenya, Pakistan, and India & South Africa) as a case study. The group members should be able to act as experts in new groups.
20 minutes
2. Redivide the class into groups of four. Each group must include a member from each of the previous expert groups. The experts should take turns informing the rest of the group regarding the various aspects of their own case study.
10 minutes
3. The following are points that can be discussed in the two groups mentioned above:

Different types of plants used by each group.

Why plants should have botanical names apart from their common names.

The various uses of the plants used in each of the regions.

Any possible similarities in the traditional indigenous knowledge from the four regions.

The possible threats to the natural environment as a result of the medicinal use of plants.

Measures that can be taken to ensure sustainable use of the natural resources.

The role of the indigenous population in establishing sustainable use of the resources.

The importance of transferring indigenous knowledge from generation to generation.

Activity 7

Table for analysing the use, type and value bases of indigenous knowledge. This table can be used as a basis for the discussion above. Complete individually or in groups before the specific case study example is discussed.

USE OF KNOWLEDGE	CASE STUDY EXAMPLE	EXAMPLES OF INDIGENOUS KNOWLEDGE	SUSTAINABLE ENVIRONMENTAL VALUES
Natural health			
Sustainable agriculture			
Sustainable resource management			
Sustainable social relationships			

Activity 8

Discussion in small groups

30 minutes

Refer to the model of the environment on p. 6 and use it to explain how each of the groups uses their indigenous knowledge to live sustainably. Explain how the values integral to the model are addressed by the people.

SYSTEMS AND VALUES OF THE ENVIRONMENT	The Maasai of East Africa	Village of Barali Kass, Kashmir in Pakistan	People living in the Himalayas of Uttar Pradesh	Indigenous knowledge in South Africa (also refer to Hoodia, p. 20)
DEMOCRACY Power, policy and decisions POLITICAL				
PEACE AND EQUITY People living together SOCIAL				
CONSERVATION Living things and life support systems BIOPHYSICAL				
APPROPRIATE DEVELOPMENT Jobs and money ECONOMIC				

Activity 9

Group activity

60 minutes

Illustrate the information gained from the discussion on a poster. Any one or more aspects can be illustrated. The poster should be presented by each group to the rest of the class. The rest of the class should comment constructively on the information depicted.

Criteria for good poster:

- Information displayed neatly
- Writing legible from a distance
- Diagrams correct, applicable
- Informative heading
- Labels and writing clear, informative, to the point
- Good use of colour and diagrams
- As much information as possible without crowding

Activity 10

Science, the food industry, the economy and indigenous knowledge:

Individual activity

15 minutes

Many modern medicines have their origins in plants, which have been used for thousands of years in the treatment of illness and disease. Plants and their derivatives contribute to more than fifty percent of all drugs used worldwide. Some well-known examples of plant-derived drugs include quinine, morphine, codeine and aspirin. Recently, new anti-cancer drugs such as Taxol, have been derived from yew (*Taxus baccata*).

There is a growing interest in natural and traditional medicines and scientists all over the world are looking for new cures in collaboration with traditional healers. In South Africa about 3 000 species are used by an estimated 200 000 traditional healers.

The harvesting of plants, their drying and analysis in laboratories mimics what traditional healers do. Laboratories use a variety of solvents to extract molecules of the active compounds which are made into medicines in the form of liquids, ointments or pills. Traditional preparation of medicines involved the reduction of plant parts into powders, infusions and smoke or fumes.

South Africa is regarded as a “hotspot” for biodiversity and more than 22 000 plant species are found here. However, very few of these plants are economically utilised. Apart from medicinal uses, plants are important as food crops and ornamental plants. Indigenous wood sources are almost depleted and can only be used on a limited scale. Dekriet (*Chondropetalum tectorum*) and dekgras (*Schizachyrium semiberbe*) are still used to thatch buildings. Bucchu, rooibos and honeybush tea, aloe and devil’s claw are plants that are exported.

The utilisation of indigenous flora can only be successfully explored if the existing indigenous knowledge of the habitats is made available to science. By forming associations between natural healers and scientists, medicinal plants can be investigated. From these associations, industries can be formed to commercialise products.

Commercial utilisation will promote the creation of small and medium entrepreneurs. This will enable communities to create wealth from indigenous knowledge, but will also ensure that natural habitats are protected. The development of ecotourism through indigenous knowledge is also becoming increasingly important.

Acknowledgement: Indigenous Plant Genetic Resources of South Africa: Cobus Coetzee, Elton Jephtas and Emmy Reinten

Questions to answer:

1. Name five indigenous South African plants that are already used with economic success. State the use of each of these plants.

2. Name three widely-used medicines that are derived from plants, as well as their application (use).

3. Explain why the conservation of our natural habitat is important.

Activity 11

Individual activity

40 minutes

Each individual now designs a pamphlet to promote the conservation of our natural habitat. The target group for whom the poster is designed are rural teenagers. These teenagers are thinking about careers and life after school. Help them decide to be involved in one of the aspects surrounding indigenous knowledge. Display the posters on the notice board.

Planning of a lesson incorporating indigenous knowledge into the curriculum

Activity 12

Discussion in small groups

30 minutes

<p>1. List the curriculum subjects and relevant topics into which the study of traditional practices and resources can be integrated.</p>	<p>2. List teaching methods based upon or similar to traditional ways of transmitting knowledge that could be used for these topics.</p>
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<p>3. List any possible barriers to integrating indigenous knowledge and traditional teaching methods into your teaching.</p>	<p>4. How might these barriers be overcome? Who can assist you to achieve this?</p>
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Activity 13

Debate on the ethics surrounding indigenous knowledge systems.

Small as well as larger groups

60 minutes

The term “bio piracy” is relatively new, but it describes an increasingly common occurrence. There is growing concern that scientists, research institutions and corporations use the indigenous knowledge of communities with very little benefit to the communities themselves.

An estimated US\$50 billion was generated for the American pharmaceutical industry in the early 1990’s alone, with a minute fraction of the value going to the people and countries from whom the knowledge was obtained.

Other problems with indigenous knowledge are the destruction of the natural habitat if medicinal plants are harvested from the wild, the loss of indigenous knowledge as younger generations follow a western lifestyle, as well as the ignorance of large parts of the world regarding the importance of indigenous knowledge.

In South Africa we have had *Hoodia* as an interesting case study recently. The following report on the issue appeared in the *Cape Times* of 23 March 2006:

Indigenous Hoodia growers fear they're being hoodwinked

BABALO NDENZE

ONLY one diet product being sold in South Africa has legitimate access to the appetite suppressant Hoodia according to the SA Hoodia Growers. In a letter to the South African German and Swiss governments the Working Group on Indigenous Minorities in Southern Africa Wimsa urged them to take steps against the continued trade in Hoodia plants and products without a share of the profits going to the San Bushmen According to Steve Hurt founder and director of the SA Hoodia Growers only Glomail's Bioslim product had access to Hoodia and in line with the agreement has to give a certain percentage of their profit back to the San.

For centuries the San have used the succulent as an appetite suppressant to stave off hunger during long hunting trips in the Kalahari desert and as a result hold intellectual property rights to the plant A benefit sharing agreement between patent owner the Council for Scientific and Industrial Research CSIR and the San was concluded in 2003 and a second agreement has since been signed between the San and the SA Hoodia Growers The Hoodia Growers will market their products with a clear logo showing that the San have received benefits Through the CSIR agreement only the licence holder Phytopharm UK and Unilever have legitimate access but at the moment the two are not selling any Hoodia products There is only one legal product and that is the Glomail product Several others are interested but none have come forward.

Let's say a business makes R20 profit the last thing most businesses want is to give away R3 of their profits to the San Everyone knows about it but guys are just taking a chance said Hurt He said there were a number of products on the market that were still using Hoodia illegally According to Hurt the agreement states that of every kilogram with their stamp of approval 6% of profits must go directly to the San.

TO DIET FOR Katrina Booie 69 holds a Hoodia a succulent used by the San to stave off hunger.
Picture SIPHIWE SIBEKO



From: Cape Times, 23 March 2006

Another matter is who should get recognition for the knowledge of traditional healers. Some scientists do not recognise the contribution of indigenous knowledge. A case in point is the “discovery” of Aspirin. Traditional healers have known for ages that the bark of the white/wild willow tree can be used as an infusion to treat headaches and fever. Yet Charles Gerhardt is credited with discovering an active form of acetylsalicylic, the active ingredient in Aspirin in 1853. Who really should be credited with this knowledge?

*Acknowledgement: Discovering Indigenous Science, Snively and Corsiglia.
IPRS and Biodiversity: Stop the theft of Indigenous Knowledge, Martin Khor.*

Activity 14

Role play in exercising debating skills on a controversial issue.

The class is divided into five groups.

60 minutes

Group 1: Scientists involved in researching the possible benefits of a medicinal plant. The plant is used by the indigenous population as an analgesic

(pain reliever). It is a species of *Headachia* and the researchers are on the verge of a breakthrough. The head of the team of scientists is Dr. Peter Knowsalot. He is very excited about the project, as this will be an analgesic without any of the side effects that other medicines have.

Group 2: **A big corporation initially contacted by the head of the research team.** The corporation, Sellataprofit, has promised the scientists to market the product worldwide if the research can prove the analgesic properties of the plant. The CEO of the company, Mr. Rick Quickprofit, is currently involved in talks with the elders of the community about growing *Headachia* plants, as well as the benefits of the project for the community,

Group 3: **The elders of the community, led by Sam Wiseman (also a traditional healer), are very worried about the exploitation of their people and the % of the profit they will eventually receive.** Unfortunately some of the elders are not very concerned about the community, but are only interested in their own pockets. Dr. Wiseman and his supporters however, feel that the community should benefit from the sales of *Headachia*. Schools and hospitals should be built. Others cannot see the reason for the upheaval; they have known about the properties of *Headachia* for generations.

Group 4: **The botanists from the university in the city are very concerned about the possible destruction of the natural habitat.** They feel that the scientists as well as the people from Sellataprofit do not care about the beautiful natural heritage as long as they can make a quick buck or get the Nobel Prize for medicine. They want to cultivate the plant in a sustainable manner. Professor Siphso Plantago and his team of postgraduate students are currently doing an in-depth study of this issue.

Group 5: **The people from the community feel that they should also have a say in the matter.** John is in grade 10 and finds it hard to do his homework and study as he has to help his father collect *Headachia* tubers, their only source of income. His father Martin has to walk further and further every day to find enough tubers. John wishes *Headachia* was never found. Mrs. Mqumbisa has to spend hours on the bus to visit the diabetes clinic in the city and wishes that their town had its own clinic. Her neighbours, the Petersen's, feel that all the scientists, botanists and new factory workers are disturbing the peace of the restful little town, Sleepy hollow.

Debate the issue from the various perspectives as explained. Each group must appoint a spokesperson to open the debate, Thereafter everybody can contribute to the debate, reacting to statements from other groups in an orderly and constructive way.

The purpose of the debate is to show group members that people have different viewpoints according to their own experiences and needs. One should respect

other people and their ideas. A solution/compromise should also be found to the following problems:

- Bio piracy
- Patenting of medicines
- Transfer of indigenous knowledge to younger generations
- The true owners of the intellectual property
- The people who should benefit from the sale of the medicine
- Who should get recognition for the knowledge that *Headachia* can relieve pain?

Activity 15

Letter to the press

Individual activity

20 minutes

Write a letter to the press clearly stating your viewpoint on the matter discussed and debated above.

The letter writer should write from the perspective of the group to which he/she belongs, as well as the persona represented.

OUR GRANDMOTHERS KNOW A LOT (OR DO THEY) ...

RESOURCE MATERIAL

INDIGENOUS KNOWLEDGE SYSTEMS AND WESTERN MODERN SCIENCE

SUITABLE FOR GET SENIOR PHASE (GRADE 9) OR FET (GRADE 10)

OUR GRANDMOTHERS KNOW A LOT (OR DO THEY?)...

LO 3, AS 1, 2 & 3

- Reading skills
- Analysing and interpretation of information

Our forefathers (and mothers) did not have the benefit of modern day medicine. They had to rely on traditional medicines and remedies. Some of these remedies are even being used today!

Study the following reading passages and discuss the questions that follow:

1. West, tells his mother to heat coarse salt, put it in a cloth and hold it against his cheek. She says the pain will go away soon.
2. Sipho has a bad summer cold. His mother does not think it is necessary to take him Daniel has a sore tooth. His grandmother, on a visit from Beaufort to a doctor. She remembers that when she was a girl, her mother used to give her a dessert spoon of brandy followed by a teaspoonful of honey and lemon juice every few hours. She does the same for Sipho.
3. Little Elizabeth has been crying with colic since late last night. Her mother is young and inexperienced and goes to the neighbour to ask her advice. The neighbour, Mrs. Tshali, recommends putting a few sprigs of the wormwood plant in a muslin bag, hanging it around the baby's neck on a piece of string so that the wormwood bag touches the baby's tummy.

Questions for discussion:

30 minutes

1. Which of the remedies, do you think, might help for the specific ailment?

_____ (2)

2. Which of the remedies will not help? Why? _____

_____ (2)

3. Can you think what the belief/reasoning behind each of the remedies is?

_____ (6)

4. Discuss each of the remedies to see if there is any scientific basis for the specific remedy. Explain.

(6)

5. Which of the remedies, in your opinion, has no scientific basis? Explain why you chose this remedy.

(3)

6. Which of the remedies might be dangerous/harmful to the sufferer? Why?

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7. One of the remedies above can be replaced by “over-the-counter” medication from the pharmacy. Can you think which? Suggest what can be bought from the pharmacy.

(3)

[25]

CRITERIA	1	2	3	4	5	6	7
Reading skills Analysing and interpretation of information	0-29% 0-7 MARKS	30-39% 8-9 MARKS	40-49% 10-12 MARKS	50-59% 13-14 MARKS	60-69% 15-17 MARKS	70-79% 18-19 MARKS	80- 100% 20-25 MARKS
LEARNER TOTAL MARKS + LEVEL							

Traditional knowledge and cultural beliefs across the world: The use of plants by indigenous peoples

LO 2 LO 3

- Reading skills
- Accessing of information
- Analysing and interpretation of information
- Group work
- Translating and explaining of information
- Debating skills

1 hour 40 minutes

2. The Maasai of East Africa:

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Acknowledgement: Ejaz Ur-Rehman, Department of Botany, University of Azad jammu and Kashmir, Pakistan.

3. The people living in the Himalayas of Uttar Pradesh

The Himalayas are divided into two administrative regions: Kumaon where the *Kumaoni* dialect is spoken and Garhwal where *Garhwali* is spoken.

The same plants grow in the two regions, but the names and uses differ. For example, *Urtica dioeca* (stinging nettle) in Garhwal is known as “*kaldiya*” and not used for anything, while in Kumaon the plant is known as “*shisoona*” and used by the local people for relieving rheumatic pains. It is either applied topically, or the leaves are eaten as a vegetable.

The people of Kumaon also cultivate the Soya bean (*Glycine soya*). It forms an important part of their diet as a plant protein. The people of Garhwal neither cultivate nor eat the Soya bean. Soya bean are very rich in protein, on a par with meat, and can help to correct the protein deficiency kwashiorkor.

Efforts to raise awareness regarding the uses of naturally growing local plants are based on the fact that people will be drawn to interesting information about plants they are familiar with. Exhibitions of useful local plants are held in various meeting places: government community services, block development offices, tea stalls and village fairs. When the people of Garhwal visit towns in Kumaon they are told about the useful plants of the area, plants also found in Garhwal.

The natural vegetation of Kumaon is, as in many other places, under threat from collecting in the wild. People also have to be taught about the medicinal uses of plants growing in the area of which they are not aware in order to promote cultivation of these plants. Indigenous knowledge therefore needs to be supplemented. This will lead to a sustainable use of plants for their own needs as well as for selling to buyers in the city.

One scheme that has already been implemented with success is the soapnut. Local people use the soapnut to wash their hands, hair and clothes, and have always collected it from the forests. They are now given soapnut tree seedlings to plant near their huts. They no longer have to collect it from the forests and have enough left to sell to urban manufacturers of shampoo.

Acknowledgement: Dr NC Shah, Centre for Indigenous Knowledge of Indian Herbal Resources, India.

4. Our own heritage: Indigenous knowledge in South Africa

Healers in South Africa use a variety of indigenous plants. It is estimated that 70% of South Africans consult traditional healers. Many of the traditional medicines used in South Africa are still derived from plants. Large quantities of plants and their extracts are sold in the informal sector.

Some of the plants used by traditional healers are:

Botanical names and common names	Indigenous medicinal uses
<i>Agathosma betulina</i> Ibuchu (Xhosa), boegoe (Afr.), bucchu (Khoisan, Eng.)	Leaves and roots are used. Treatment of kidney and urinary tract diseases. Applied locally to bruises and rheumatic pains. Leaves chewed for stomach complaints. Infusions used against fever, tiredness and congestion of chest.
<i>Aloe ferox</i> Ikhala (Xhosa), bitteraalwyn (Afr.), Cape aloe (Eng.)	Mainly leaves are used. Fresh leaf juice used to treat conjunctivitis. Powder from charred leaves for venereal sores. Ground leaves used for snuff. Traditionally used to treat arthritis, eczema and hypertension. Applied externally to treat skin irritations, burns and bruises.
<i>Artemisia affra</i> Umdlonyane (Xhosa, Zulu), wildeals (Afr.), African wormwood Eng.)	Highly aromatic leaves used as tea for stomach complaints. Crushed leaves commonly inhaled for headaches and colds. Treatment of measles and malaria. Powders in milk or water used as enemas, against intestinal worms.
<i>Salix mucronata</i> Umngcunube (Xhosa), wilde wilger (Afr.), wild willow (Eng.)	Branch tips and leaves are used. Against rheumatism and fever. Plant has anti-inflammatory properties. Aspirin, the analgesic, derived from this plant.

The leaves and roots of edible plants can have an important nutritional value in the rural areas where malnutrition often occurs. With urbanisation however, there is a movement away from traditional crops and more Western eating habits are developing.

Some of the indigenous food types such as rooibos tea (*Aspalathus linearis*) and honeybush tea (*Cyclopia* spp.) have developed as an agricultural industry with export potential. Bucchu, one of the traditional medicinal plants, is exported in large volumes. This however, is not for medicinal uses but mainly as a fixative in the food industry. Bucchu is also used on a small scale in the ornamental industry. Only aloe and devil's claw (*Harpagophytum procumbens*) are exported for medicinal use.

Acknowledgement: Iziko South African Museum: ulwazi lwemvelo – indigenous knowledge in South Africa.

Questions for discussion

1. Divide the class into four expert groups. These groups must each discuss one of the above countries (Maasai from Kenya, Pakistan, and India & South Africa) as a case study. The group members should be able to act as experts in new groups.
20 minutes
2. Redivide the class into groups of four. Each group must include a member from each of the previous expert groups. The experts should take turns informing the rest of the group regarding the various aspects of their own case study.
20 minutes
3. The following are points that can be discussed in the two groups mentioned above:
 Different types of plants used by each group.
 Why plants should have botanical names apart from their common names.
 The various uses of the plants used in each of the regions.
 Any possible similarities in the traditional indigenous knowledge from the four regions.
 The possible threats to the natural environment as a result of the medicinal use of plants.
 Measures that can be taken to ensure sustainable use of the natural resources.
 The role of the indigenous population in establishing sustainable use of the resources.
 The importance of transferring indigenous knowledge from generation to generation.

CRITERIA	1	2	3	4	5	6	7
<ul style="list-style-type: none"> ➤ Reading skills ➤ Accessing of information ➤ Analysing and interpretation of information ➤ Group work ➤ Translating and explaining of information ➤ Debating skills 	Cannot cooperate in group, no participation, apathetic, does not take part, little or no communication Not able to analyze and interpret data, no conclusion possible	Takes part to certain extent, degree of cooperation and communication Can analyze data to certain extent, cannot interpret, try to make conclusion	Involves most of the group members, relatively good communication, sometimes delegates tasks Can analyze and interpret data to certain extent, makes conclusion, conclusion can be partly incorrect	Analyses and interprets data, makes basic conclusions, communicates conclusion to group		Excellent cooperation, involves all group members, good communication skills, delegates tasks, takes lead Able of analysis and interpretation of data, making of scientific conclusions, takes lead in group with thought processes	
PREDOMINANT LEVEL ACHIEVED							

IF PEOPLE CAN SEE THEY REMEMBER WHAT THEY HEAR: POSTER ON USE OF PLANTS BY INDIGENOUS PEOPLES

Illustrate the information gained from the discussion on a poster. Any one or more aspects can be illustrated. The poster should be presented by each group to the rest of the class. The rest of the class should comment constructively on the information depicted.

60 minutes

Criteria for good poster:

- Information displayed neatly
- Writing legible from a distance
- Diagrams correct, applicable
- Informative heading
- Labels and writing clear, informative, to the point
- Good use of colour and diagrams
- As much information as possible without crowding

CRITERIA	1	2	3	4	5	6	7
Poster handed in on time	Poster handed in more than two days late		Poster handed in two days late		Handed in one day late		Poster handed in on time
Criteria for good poster	Poster handed in, but does not answer to any of the criteria	Answers to only one of criteria	Answers to only two of criteria	Poster answers to three of the criteria	Poster answers to four of the criteria for a good poster	Answers to five or six of the criteria	Poster answers to all seven criteria for a good poster
PREDOMINANT LEVEL ACHIEVED							

SCIENCE, THE FOOD INDUSTRY, THE ECONOMY AND INDIGENOUS KNOWLEDGE

- Reading skills
- Analysing and interpreting information
- Making of scientific conclusions

Many modern medicines have their origins in plants, which have been used for thousands of years in the treatment of illness and disease. Plants and their derivatives contribute to more than fifty percent of all drugs used worldwide. Some well-known examples of plant-derived drugs include quinine, morphine, codeine and aspirin. Recently, new anti-cancer drugs such as Taxol, have been derived from yew (*Taxus baccata*).

There is a growing interest in natural and traditional medicines and scientists all over the world are looking for new cures in collaboration with traditional healers.

In South Africa about 3 000 species are used by an estimated 200 000 traditional healers.

The harvesting of plants, their drying and analysis in laboratories mimics what traditional healers do. Laboratories use a variety of solvents to extract molecules of the active compounds which are made into medicines in the form of liquids, ointments or pills. Traditional preparation of medicines involved the reduction of plant parts into powders, infusions and smoke or fumes.

South Africa is regarded as a “hotspot” for biodiversity and more than 22 000 plant species are found here. However, very few of these plants are economically utilised. Apart from medicinal uses, plants are important as food crops and ornamental plants. Indigenous wood sources are almost depleted and can only be used on a limited scale. Dekriet (*Chondropetalum tectorum*), and dekgras (*Schizachyrium semiberbe*) is still used to thatch buildings. Bucchu, rooibos and honeybush tea, aloe and devil’s claw are plants that are exported.

The utilisation of indigenous flora can only be successfully explored if the existing indigenous knowledge of the habitats is made available to science. By forming associations between natural healers and scientists, medicinal plants can be investigated. From these associations, industries can be formed to commercialise products.

Commercial utilisation will promote the creation of small and medium entrepreneurs. This will enable communities to create wealth from indigenous knowledge, but will also ensure that natural habitats are protected. The development of ecotourism through indigenous knowledge is also becoming increasingly important.

Acknowledgement: Indigenous Plant Genetic Resources of South Africa: Cobus Coetzee, Elton Jephthas and Emmy Reinten

Questions to answer:

15 minutes

1. Name five indigenous South African plants that are already used with economic success. State the use of each of these plants.

(10)

2. Name three widely-used medicines that are derived from plants, as well as their application (use).

(6)

3. Explain why the conservation of our natural habitat is important.

(4)

[20]

CRITERIA	1	2	3	4	5	6	7
	0-29% 0-5 MARKS	30-39% 6-7 MARKS	40-49% 8-9 MARKS	50-59% 10-11 MARKS	60-69% 12-13 MARKS	70-79% 14-15 MARKS	80-100% 16-20 MARKS
LEARNER TOTAL MARK + LEVEL							

TEENAGERS SHOULD BE AWARE OF THE VALUE OF THE KNOWLEDGE THEIR ELDERS POSSESS

- Reading skills
- Analysing and interpretation of information
- Graphic representation of information

Each individual designs a pamphlet (brochure) to promote the conservation of our natural habitat and indigenous knowledge. The target group for whom the pamphlet is designed are rural teenagers. These teenagers are thinking about careers and life after school. Help them decide to be involved in one of the aspects surrounding indigenous knowledge. Display the pamphlets on the notice board.

40 minutes

Criteria for good pamphlet

- As little as possible information with as much as possible impact
- Good use of colour

- Heading stating contents/ purpose clearly
- Contact details provided
- Emotional/ intellectual approach
- Clear diagrams and pictures
- Neatness

CRITERIA	1	2	3	4	5	6	7
Pamphlet handed in on time	Pamphlet handed in more than two days late		Pamphlet handed in two days late		Handed in one day late		Pamphlet handed in on time
Criteria for good pamphlet	Pamphlet handed in, but does not answer to any of the criteria	Answers to only one of criteria	Answers to only two of criteria	Pamphlet answers to three of the criteria	Pamphlet answers to four of the criteria for a good poster	Answers to five or six of the criteria	Pamphlet answers to all seven criteria for a good poster
PREDOMINANT LEVEL ACHIEVED							

INDIGENOUS PEOPLE ARE SOMETIMES EXPLOITED BY MONEYMAKERS

Debate on the ethics surrounding indigenous knowledge systems.

60 minutes

The term “bio piracy” is relatively new, but it describes an increasingly common occurrence. There is growing concern that scientists, research institutions and corporations use the indigenous knowledge of communities with very little benefit to the communities themselves.

An estimated US\$50 billion was generated for the American pharmaceutical industry in the early 1990’s alone, with a minute fraction of the value going to the people and countries from whom the knowledge was obtained.

Other problems with indigenous knowledge are the destruction of the natural habitat if medicinal plants are harvested from the wild, the loss of indigenous knowledge as younger generations follow a western lifestyle, as well as the ignorance of large parts of the world regarding the importance of indigenous knowledge.

In South Africa we have had *Hoodia* recently as an interesting case study. The following report appeared in the *Cape Times* of 23 March, 2006.

Indigenous Hoodia growers fear they're being hoodwinked

BABALO NDENZE

ONLY one diet product being sold in South Africa has legitimate access to the appetite suppressant Hoodia according to the SA Hoodia Growers. In a letter to the South African German and Swiss governments the Working Group on Indigenous Minorities in Southern Africa Wimsa urged them to take steps against the continued trade in Hoodia plants and products without a share of the profits going to the San Bushmen According to Steve Hurt founder and director of the SA Hoodia Growers only Glomail's Bioslim product had access to Hoodia and in line with the agreement has to give a certain percentage of their profit back to the San.

For centuries the San have used the succulent as an appetite suppressant to stave off hunger during long hunting trips in the Kalahari desert and as a result hold intellectual property rights to the plant A benefit sharing agreement between patent owner the Council for Scientific and Industrial Research CSIR and the San was concluded in 2003 and a second agreement has since been signed between the San and the SA Hoodia Growers The Hoodia Growers will market their products with a clear logo showing that the San have received benefits Through the CSIR agreement only the licence holder Phytopharm UK and Unilever have legitimate access but at the moment the two are not selling any Hoodia products There's only one legal product and that is the Glomail product Several others are interested but none have come forward.

Let's say a business makes R20 profit the last thing most businesses want is to give away R3 of their profits to the San Everyone knows about it but guys are just taking a chance said Hurt He said there were a number of products on the market that were still using Hoodia illegally According to Hurt the agreement states that of every kilogram with their stamp of approval 6% of profits must go directly to the San.

TO DIET FOR Katrina Booie 69 holds a Hoodia a succulent used by the San to stave off hunger.
Picture SIPHIWE SIBEKO



From: Cape Times, 23 March 2006

Another matter is who should get recognition for the knowledge of traditional healers. Some scientists do not recognise the contribution of indigenous knowledge. A case in point is the “discovery” of Aspirin. Traditional healers have known for ages that the bark of the white/wild willow tree can be used as an infusion to treat headaches and fever. Yet Charles Gerhardt is credited with discovering an active form of acetylsalicylic, the active ingredient in Aspirin in 1853. Who really should be credited with this knowledge?

*Acknowledgement: Discovering Indigenous Science, Snively and Corsiglia.
IPRS and Biodiversity: Stop the theft of Indigenous Knowledge, Martin Khor.*

Role play in exercising debating skills on a controversial issue.

60 minutes

The class is divided into five groups.

Group 1: **Scientists involved in researching the possible benefits of a medicinal plant.** The plant is used by the indigenous population as an analgesic (pain reliever). It is a species of *Headachia* and the researchers are on the verge of a breakthrough. The head of the team of scientists is Dr. Peter Knowsalot. He is very excited about the project, as this will be an analgesic without any of the side effects that other medicines have.

Group 2: **A big corporation initially contacted by the head of the research team.** The corporation, Sellataprofit, has promised the scientists to market the product worldwide if the research can prove the analgesic properties of the plant. The CEO of the company, Mr. Rick Quickprofit, is currently involved in talks with the elders of the community about growing *Headachia* plants, as well as the benefits of the project for the community,

Group 3: **The elders of the community, led by Sam Wiseman (also a traditional healer), who are very worried about the exploitation of their people and the % of the profit they will eventually receive.** Unfortunately some of the elders are not very concerned about the community, but are only interested in their own pockets. Dr. Wiseman and his supporters however, feel that the community should benefit from the sales of *Headachia*. Schools and hospitals should be built. Others cannot see the reason for the upheaval; they have known about the properties of *Headachia* for generations.

Group 4: **The botanists from the university in the city are very concerned about the possible destruction of the natural habitat.** They feel that the scientists as well as the people from Sellataprofit do not care about the beautiful natural heritage as long as they can make a quick buck or get the Nobel Prize for medicine. They want to cultivate the plant in a sustainable manner. Professor Sipho Plantago and his team of postgraduate students are currently doing an in-depth study of this issue.

Group 5: **The people from the community feel that they should also have a say in the matter.** John is in grade 10 and finds it hard to do his homework and study as he has to help his father collect *Headachia* tubers, their only source of income. His father Martin has to walk further and further every day to find enough tubers. John wishes *Headachia* was never found. Mrs. Mqumbisa has to spend hours on the bus to visit the diabetes clinic in the city and wishes that their town had its own clinic. Her neighbours, the Petersen's, feel that all the scientists, botanists and new factory workers are disturbing the peace of the restful little town, Sleepy hollow.

Debate the issue from the various perspectives as explained. Each group must appoint a spokesperson to open the debate, Thereafter everybody can contribute to the debate, reacting to statements from other groups in an orderly and constructive way.

The purpose of the debate is to show group members that people have different viewpoints according to their own experiences and needs. One should respect other people and their ideas. A solution/compromise should also be found to the following problems:

- Bio piracy
- Patenting of medicines
- Transfer of indigenous knowledge to younger generations

- The true owners of the intellectual property
- The people who should benefit from the sale of the medicine
- Who should get recognition for the knowledge that *Headachia* can relieve pain?

Letter to the press

20 minutes

Write a letter to the press clearly stating your viewpoint on the matter discussed and debated above.

The letter writer should write from the perspective of the group to which he/she belongs, as well as the persona represented.

WORKSHOP FOR EDUCATORS

5 MAY 2007 at CEDAR HIGH SCHOOL

WESTERN SCIENTIFIC KNOWLEDGE VS/AND INDIGENOUS KNOWLEDGE SYSTEMS

8:00 – 8:30	Welcome and registration
8:30 – 9:00	Activity
9:00 – 9:30	Feedback on activity
9:30 – 10:00	Activity
10:00 – 10:30	Feedback on activity
10:30 – 11:00	Tea
11:00 - 12: 00	Integration of WS and IKS
12:00 – 12:45	Lunch
12:45 – 13:15	Activity
13:15 – 13: 45	Feedback on activity
13: 45	Closure and thanks

TEACHER INTERVIEW

[Name] thank you for agreeing to this interview. As you know, I am interested in the problems educators encounter in the integration of indigenous knowledge and scientific knowledge, as well as the implementation of learning outcome 3.

There are just 19 questions, and perhaps there are more things which you may wish to add. So, shall we begin with the first question? I will be taking some notes whilst you are talking, but I'll also record the interview. So I'll turn on the tape now, OK? Let's begin.

Question 1

Are you familiar with the term constructivism? If so what does it mean to you?

Question 2

Do you consider yourself to be a constructivist science teacher? If so, give an example of what a visitor to your class might see that is an example of constructivism in a lesson topic of your choice?

Question 3

Was the workshop you attended an example of constructivism? Motivate

Question 4

What, in your view, are the benefits (advantages) of a constructivist way of teaching?

Question 5

What barriers are present that makes it difficult for you to include constructivist teaching practices?

Question 6

Do you believe in a learner-centered classroom? Can you define a learner-centered classroom?

Question 7

Can you define "good science teaching"/ 'effective science teaching'? How do you see your role as an effective science teacher in the new curriculum?

Question 8

The new curriculum states that local knowledge (indigenous knowledge) should be included in the curriculum. Is it possible to adhere to this statement, and what are the problems you may encounter?

Question 9

How do you address diversity in the classroom and do you consider the worldviews of the learners when you are teaching?

Question 10

Learners differ in ability. How would you ensure that students had multiple ways of demonstrating their ability?

Question 11

In the new curriculum learners have ‘shared control’ and also plan what they are going to learn. Do you believe that learners have some decision making ability in the course curriculum? Motivate your answer.

Question 12

In the new curriculum learners have some ‘personal relevance’ and learn how science can be part of out-of-school life. Do you believe that it is important for learners to have some personal interest in the content of the curriculum? Motivate your answer.

Question 13

In the new curriculum learners have a ‘critical voice’ and it is OK to ask the teacher “Why do we have to learn this?” Do you feel that learners are free to question the teachers’ practice? Motivate your answer.

Question 14

Do you think that your participation in this research affected what happened in your classroom in ways that you expected? Explain your answer.

Question 15

After you had been trained with regard to the integration of indigenous knowledge in the curriculum, did the training change your teaching practice? If yes, in what way?

Question 16

In the time since the training, what have you learned by using the method suggested by the workshop?

Question 17

In the workshop you were provided with two models for teaching indigenous knowledge. In the classroom observation you had to choose one. Which one did you choose, and motivate why you chose that specific model?

Question 18

Would you use the kind of activities that you were exposed to in the workshop in future lessons? Motivate your answer.

Question 19

Would you recommend that other educators should also be trained in the integration, or do you feel that educators will be able to cope on their own? Motivate.

Thank you [Name], is there anything else you want to say?

CONSENT FORM

I hereby give permission for my child to participate in the research regarding the **INTEGRATION OF INDIGENOUS KNOWLEDGE IN THE SCIENCE CLASSROOM**. I understand that my child is participating freely and without compulsion. I also understand that my child can stop the interview at any point, should they choose not to continue. The decision to discontinue their participation will not affect them negatively.

The purpose of the study has been explained to me, and I understand what is expected of my child's participation. I understand that this is a research study, and the purpose of the research may not benefit me personally.

I have received the telephone numbers of a person to consult, should I need to speak about any issues that may develop from the interview.

Signature of parent:

Date:

In addition to the above, I hereby agree to the audio recording of the interview. I understand that no personally identifying information or recording concerning my child will be released in any form. I understand that these recordings will be kept in a secure environment, and will be destroyed or erased once the data capture and analysis has been completed.

Signature of parent:

Date:

LEARNER INTERVIEW

QUESTION 1

What is your name (or nickname), and how old are you?

QUESTION 2

How did you find the lesson that your teacher gave which was video-taped? Explain your answer.

QUESTION 3

Can you maybe give some responses of other learners in your class after the particular lesson? Explain your answer.

QUESTION 4

What was different in that particular lesson than in the case of other lessons which your teacher normally teaches? Explain your answer.

QUESTION 5

Which way do you prefer your teacher to teach?

- a) firstly by finding out what you know about the topic and then proceeding with the lesson or
- b) immediately starting to explain the topic.

Explain your answer.

QUESTION 6

Do you think that the science that your teacher teaches you at school differ to what your parents teach you at home? Explain your answer.

QUESTION 7

The things that your parents teach are what are called local knowledge. This local knowledge can sometimes be a problem. What will you do if a learner in your class tells you something which you do not believe/ is different to what you belief?

QUESTION 8

Do you think that the local knowledge (which your parent teaches you), as well as what you hear in your community, influences the way you understand what the teacher teaches you science in school? Explain your answer.

Udliwano – ndlebe nomfundi

Umbuzo 1

Ngubani igama lakho, ngubani obizwa ngalo ngabahlobo bakho, mingaphi iminyaka yakho .

Umbuzo 2

Usibone sinjani isifundo ebesiqhutywa ngititshala wakho esebenzisa ushicilelo lwevidiyo. Cacisa impendulo yakho.

Umbuzo 3

Ungasinika ezinye zempendulo zabafundi eklasini yakho emva kwesifundo. Cacisa impendulo yakho.

Umbuzo 4

Yintoni umahluko kwesisifundo kunezinye izifundo ezidla ngokuqhutywa ngutitshala wakho. Cacisa ngempendulo yakho.

Umbuzo 5

Yeyiphi indlela ongathanda ukuba utitshala wakho ahlohle ngayo:

- (a) Ungathanda kuqala azi into oyaziyo malunga nesisifundo aze emva koko athathele apho aqhubekeke nesifundo sakhe.
- (b) Okanye zisuka nje acacise ngesihloko sesifundo salo mhla.

Umbuzo 6

Ingaba isifundo sobunzululwazi osifundiswa ngutitshala wakho sohluke njani kwesi usifundiswa ngabazali bakho ekhaya? Cacisa impendulo yakho.

Umbuzo 7

Izinto ozifundiswa ngabazali bakho zizinto esisenokuzibiza ngokuba lulwazi lwasekuhlaleni. Olu lwazi ngelinye ixesha ludala iingxaki.

Umzekelo:- omnye umntwana eklasini yakho uthe umakazi wakhe uthe unako ukusinyanga isifo sikagawulayo. Ungathini xa umfundi oseklasini yakho ekuxelela into ongakholelwa kuyo okanye engadibani nento okholelwa kuyo.

Umbuzo 8

Ucinga ukuba olu lwazi lwasekhaya (lwazi olo lufundiswa ngabazali bakho) kwakunye nolo- ulufumana ekuhlaleni lunempembelelo kwiindlela ezo uthi uqonde imfundiso zikatitshala ngenzululwazi okanye lwenza kube nzima ukudibanisa nolwazi lukatishala. Cacisa

BET – Before training

NAME OF TEACHER: Bet

DATE: 16 October 2008.

GRADE: 12

TOPIC: Reflex arc

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	1	The topic of the lesson was the reflex arc. The chosen topic has no IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited opportunity (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	Before the educator proceeded with the day's lesson, she asked seven learners out of a class of thirty four learners questions, who all responded, to revise the previous day's work. By means of the question and answer method the educator attempted to find out what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only	1	After the initial question and answer session to revise the previous day's work, the educator then proceeded with the new lesson. Fourteen learners were asked questions of whom twelve

		<p>10% of learners) was given to the learners to express their personal ideas, beliefs and opinions.</p> <p>3. The teacher allowed the learners to express their personal ideas, beliefs and opinions.</p>		<p>responded. During the explanation of the new lesson the educator again skillfully used the question and answer method, all the time writing a summary on the blackboard. However, no opportunity was given to the learners to express their own ideas. Even when the learners answered a question which was not the preferred answer, the educator would guide the learners so that they could provide the answer that she expected.</p>
3. Research the various perspectives.	A. Research the western science perspective.	<p>1. No reference was given to the western scientific perspective.</p> <p>2. A limited reference was given to the western scientific perspective (a brief verbal reference).</p> <p>3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information).</p>	3	<p>The educator explained the reflex arc to the learners. After explaining how the reflex arc functions, she asked the learners if they had been to a medical doctor to have their reactions tested. She then demonstrated what a medical doctor would do if he/she tested their reactions. Thereafter she provided poster boards to the learners where they had to answer an activity in their groups. This activity was about a man and his wife who was involved in a car accident. In their groups the learners discussed the consequences when the man and his wife were tested by pricking the fingertip of each with a pin. Extensive reference was therefore given to the western scientific perspective.</p>
	B. Research the various indigenous perspectives	<p>1. No reference was given to the indigenous knowledge perspective.</p> <p>2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference).</p> <p>3. Extensive reference was given to the</p>	1	<p>After explaining the medical aspects of the reflex arc, the learners were given an opportunity to discuss amongst themselves the reflex arc by means of a case study. However, no reference was given to the indigenous perspective, and only the western scientific</p>

		indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information).		perspective was discussed.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	1	This lesson was about the reflex arc. The educator explained this lesson from a western scientific perspective , for example giving a medical explanation. No reference was given to the indigenous perspective. Therefore no attempt was made by the educator to compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful 	1	The lesson started with the educator first revising the previous day's work. Thereafter the educator explained the structure of the reflex arc by means of the question and answer method. The learners were then given an opportunity to engage with the information by discussing a case study . The lesson ended after the information was given to the learners. The educator only considered a western scientific perspective. Therefore no opportunity was provided to the learners to consider the consequences of the respective perspectives.

		discussion).		
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives). 	1	The lesson was only from a western scientific perspective. The educator did not inform the learners that there were maybe alternative ways to look at the treatment of the two patients mentioned in the case study. Therefore no opportunity was given to the learners to synthesise the two perspectives.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were made to highlight the values and ethics associated with each perspective. 	1	The educator explained the reflex arc from a western scientific perspective. After the learners completed the case study of the husband and wife who were involved in an accident, she asked the learners how they would feel if they were paralysed. During this discussion some values and ethics associated with the western scientific perspective were discussed. Some values for example respect , dignity and compassion were mentioned by the learners. For example one learner mentioned: "I would like people to treat me like a normal person and to treat me fairly and people not to discriminate me. I would feel helpless and would not have a reason to live anymore".
5. Evaluate the process.	A. Has the teacher checked whether there has been a	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 	1	The entire lesson was about the reflex arc from a western scientific perspective. Not once during the lesson did the educator mention

	shift in opinion about the two perspectives?	<p>2. A limited opportunity was given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire).</p>		about the indigenous perspective Therefore the educator did not check whether there was a shift in opinion about the two perspectives because the educator only concentrated on the western perspective.
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<p>1. No attempt was made to check whether the shift in opinion would inform future actions.</p> <p>2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were made to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario).</p>	1	Because the entire lesson was from a western scientific perspective, there could be no shift in opinion about the two perspectives. The educator therefore did not check whether the shift in opinion would inform future actions.

Bet – After training

NAME OF TEACHER: Bet.

DATE: 24 October 2008

GRADE: 11

TOPIC: Biodiversity

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic chosen was biodiversity. At a first glance there was a possibility that there may be a link between IK and the topic. However, as the lesson unfolded it became quite clear that there was a clear link between the topic and IK. The lesson started where the educator informed the learners about the herb that grew somewhere in the field and about the people living there who knew about the wormwood and its uses. There was a clear IK link to the topic.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all	3	The educator divided the class into different groups . Each group was provided with a certain herb (wormwood). The educator then asked the learners whether they knew what the herb was and what it was used for. All the learners could identify the herb. The learners then explained what the wormwood was used for and how they used the wormwood at home. In this manner the

		opinions to be expressed.		educator attempted to establish what the learners knew about the topic.
	B. Identify personal ideas, beliefs and opinions.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs and opinions. 	3	The class was divided into groups , where the topic was discussed . The educator asked five learners questions about the wormwood. The learners explained how they drank the wormwood and also how they brewed the wormwood. When a learner mentioned that he added salt and garlic to the wormwood brew, the educator was bewildered and enquired what the purpose was of adding salt and garlic. The learner explained that it helped with the sore throat. In this manner the personal opinion and ideas of the learners were identified.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The class was divided into five different groups , namely the scientists, the botanists, the big corporations, the elders, and people of the community. The educator gave each group a piece of paper with information which they had to read. In their groups the learners first discussed the information. The scientist and the big corporation gave a western scientific perspective. The big corporations (i.e. the pharmaceutical companies) for example promised the scientist that would market the products of the herb worldwide. The scientists, on the other hand, were involved in researching the possible benefits of the medicinal plant. By discussions , firstly in their groups and secondly debating the issue. After the debate the learners again discussed amongst

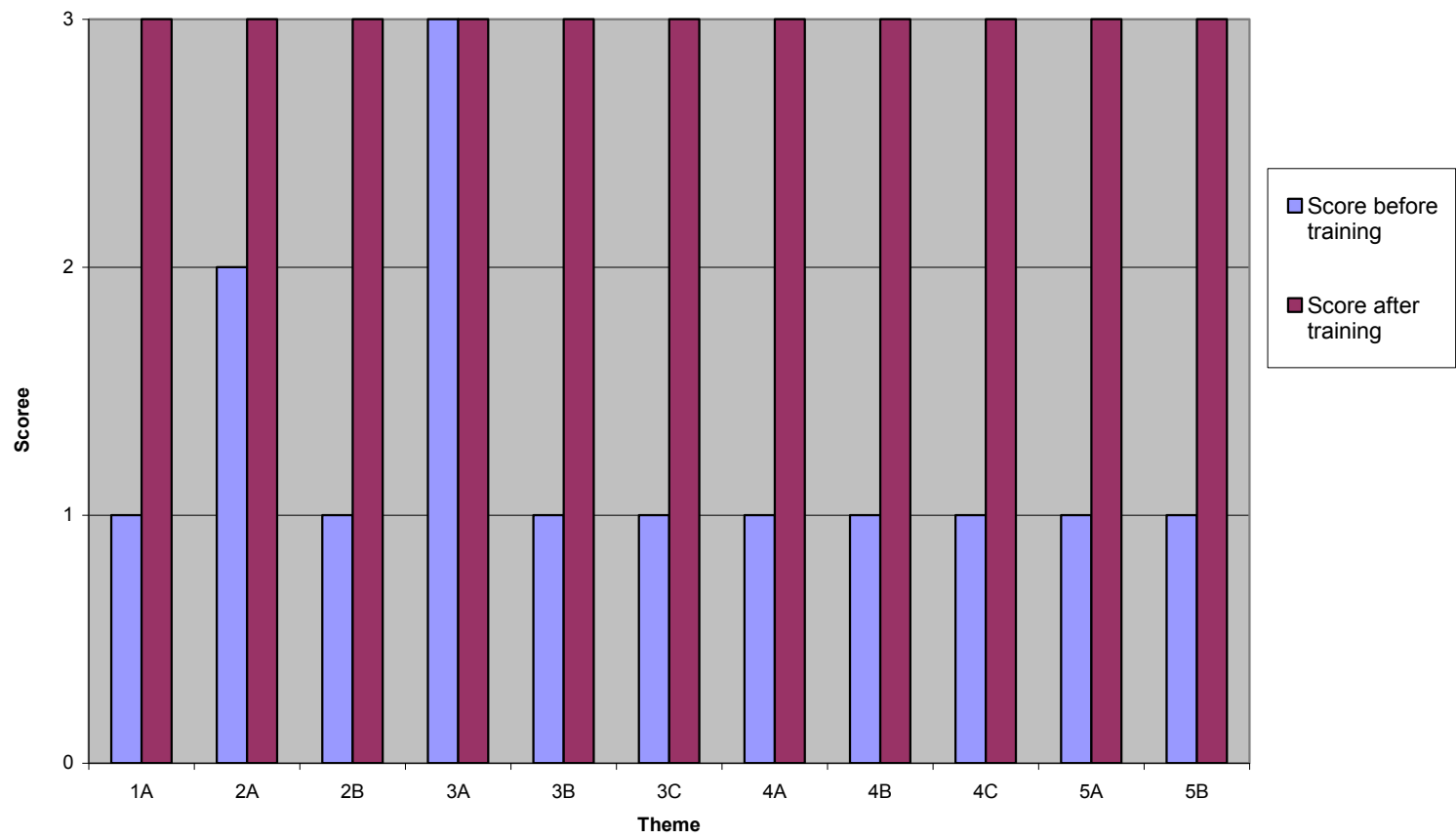
				themselves issues that the other groups had raised. In this manner the learners were able to engage with the information.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	As mentioned earlier, the class was divided into five groups . Three groups, namely the elders, botanists as well as the people of the community gave the indigenous knowledge perspective. The elders were worried about exploitation of their people and the percentage profit that they would eventually receive. The people of the community on the other hand felt that they should also have a say in the matter. The botanists were also concerned about the possible destruction of the natural habitat. The learners discussed , firstly in their groups , the indigenous perspective. Secondly, the learners debated with the other groups the issues. This was followed by a discussion between the learners again of the issues raised. In this manner the learners were able to engage with the information.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	3	After the learners discussed the various perspectives in their groups , a debate followed and the similarities and differences between the two perspectives were compared. This was followed by a discussion between the learners again of the issues raised. In this manner the learners were able to compare the two perspectives.
4. Reflect.	A. Consider the	1. No opportunity was given to the	3	The Big Corporations and Scientists (western

	consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<p>learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given).</p> <ol style="list-style-type: none"> 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 		<p>scientific perspective) for financial gain whilst the Elders (indigenous perspective) said that everyone must benefit. Opportunities were provided by the educator which included: discussion amongst the learners; followed by a debate between the different groups; followed by discussions of the issues raised. The learners were engaging in meaningful discussions.</p>
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the 	3	<p>The educator divided the class into five different groups. Each group represented either an indigenous perspective or a western scientific perspective, although it was not explicitly stated as such. The learners were given the instruction that they must discuss, in their group, the different view that was expressed on the piece of paper. After discussing in their groups, the different groups debated the topic. Every group stated how they felt. At the end there was disagreement amongst the various perspectives. The educator then allowed the different groups to discuss</p>

		two perspectives).		amongst themselves what was summarized on the blackboard, i.e. the main points that each group had suggested. This was followed by another discussion amongst the different groups. All the groups then agreed that everyone should benefit namely the community, the scientist, the botanist, and the elders of the community but not the big corporations. In this manner the learners developed their own understanding of the importance of synthesizing the two perspectives.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were made to highlight the values and ethics associated with each perspective. 	3	As mentioned earlier, the learners first discussed amongst themselves in their groups their viewpoints. This was followed by a debate between the different groups. As the debate progressed the educator noticed that there were disagreements between the groups. She then allowed the groups to talk amongst them again. When the debate followed again, all the groups agreed that there must be a compromise. They all came to an agreement that the plant belonged to everyone and that clinics must be built that would benefit everyone in the community. Opportunities were therefore provided to highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to 	3	After the second round of the debate , the different groups discussed the percentage profit each group should get. Initially all groups gave their expected percentage. All the groups were just thinking about the money they could make.

	perspectives?	<p>check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were made to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire).</p>		<p>However, as the debate progressed it became quite clear that no group could say that the plant belonged to them. Consequently their way of thinking about this plant changed. The debate then changed where every group agreed that clinics should be build which would benefit the community. In this way the educator has skillfully checked whether there was a shift in opinion about the two perspectives.</p>
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<p>1. No attempt was made to check whether the shift in opinion would inform future actions.</p> <p>2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were made to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario).</p>	3	<p>The educator checked whether their shift in opinion would inform future actions. This came out during the first group discussions; first debate; second group discussions; as well as the second debate. A learner said the following: "Build more clinics. Give the people only 5% because they are just trying to make money out of us." So it changed their way of thinking.</p>

Summary of Bet's Scores



Mikes – Before training

NAME OF TEACHER: Mikes

DATE: 16 October 2008.

GRADE: 8

TOPIC: Medicines and its uses.

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was medicines and its uses. There was a clear IK link to the topic.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By means of the question and answer method the educator skillfully sought information from the learners to enquire from them what they know about the topic. Questions were only asked to twelve learners out of a class of thirty eight learners. A limited attempt was made by the educator to brainstorm what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal	2	By means of the question and answer method the educator made a limited attempt for the learners to express their opinions. Questions were only asked to ten learners who responded to the questions.

		ideas, beliefs and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs and opinions.		
3. Research the various perspectives.	A. Research the western science perspective.	1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information).	2	The educator explained that if the learners were ill, their parents would take them to the medical doctor to heal them. These doctors obtained their knowledge from the westernized part, which is western scientific knowledge. The educator made a limited attempt to explain the western scientific perspective.
	B. Research the various indigenous perspectives	1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information).	2	The educator explained that the people of many years ago did not go to the doctors but used herbs to heal them. He mentioned that the traditional healers were approached who used the traditional herbs to heal the people. No opportunity was given to the learners to explore the topic further. The educator made a limited attempt to explain the indigenous knowledge perspective.
	C. Organize/ process the perspectives by	1. No opportunity was given to the learners to compare the two perspectives.	2	The educator showed the learners various bottles of home remedies for example Jamaica Ginger, <i>wit dulsies</i> , <i>versterk druppels</i> . He

	comparing them (similarities and differences).	<ol style="list-style-type: none"> 2. A limited opportunity was given to the learners to compare the two perspectives (a brief verbal comparison of the two perspectives). 3. Extensive opportunities were given to the learners to compare the two perspectives. 	<p>explained to the learners what each of the home remedies were used for. Then the educator referred to the western medicines. He compared the two kinds of medicines and asked the learners if the one was better than the other one. For example if indigenous knowledge were better than western science or whether the two could work together. The educator made a limited attempt to compare the indigenous and the western scientific perspective.</p>
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4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	3	The educator divided the learners into groups . In their groups the learners discussed what indigenous knowledge and western science meant. They also had to give examples of these two perspectives. After the group discussions, the learners had to report back to the rest of the class what they understood about the two perspectives. In this manner some meaningful discussion took place between the individual groups as well as between the learners in the class.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the 	2	After a discussion of the two perspectives, the educator explained the condition called AIDS. The educator explained that the former minister of health, Msimang, said that if you use certain herbs, for example African potato and garlic amongst other things you would be able to cure AIDS. However, antiviral drugs must also be used. Therefore using the herbs, which was indigenous knowledge, and combining it with antiviral drugs, which was western science, and then you may live a few years longer. In this manner the two perspectives were synthesized

		two perspectives.		by the educator.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<p>1. No attempt was made to highlight the values and ethics associated with each perspective.</p> <p>2. A limited attempt was made to highlight the values and ethics associated with each perspective.</p> <p>3. Extensive opportunities were made to highlight the values and ethics associated with each perspective.</p>	1	After an explanation of the two perspectives, the educator then divided the class into different groups where they had to explain what IK was and what western science was and they had to give examples of each. Although the educator explained how the indigenous knowledge and the western science complemented each other with the example of AIDS, he did not take it to the next level. In other words he did not highlight the value and wisdom associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<p>1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives.</p> <p>2. A limited opportunity was given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire).</p>	1	The educator first gave an explanation of what western science and IK was. After his explanation he divided the class into groups where the two perspectives were discussed by the learners. After the discussion the learners gave a report back of their understanding of western science and IK as well as examples of the two perspectives.
	B. Has the teacher checked how the shift in opinion would inform	<p>1. No attempt was made to check whether the shift in opinion would inform future actions.</p> <p>2. A limited opportunity was made</p>	1	After completion of the lesson the educator checked what the learners wrote on their poster boards. There was also some feedback from the learners on their understanding of IK and

	<p>future actions (e.g. consider home remedy or western perspective when appropriate)</p>	<p>to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario).</p>		<p>western science. However, the educator did not check whether there was a shift in the opinion of the various perspectives and whether the shift would inform their future actions. At the end of the lesson the educator only asked the class to sum up what they thought the lesson of the day was about.</p>
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Mikes – After training

NAME OF TEACHER: Mikes

DATE: 24 October 2008.

GRADE: 11

TOPIC: Medicines and its uses

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was medicines and its uses. The chosen topic has a clear link to IK
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator whispered a sentence to the learner in the front of the class and asked the learner to pass on the message to the rest of the class. After the message reached the last person in the class, the educator enquired what the message was. The educator explained to the class that the exercise that they had just completed was the manner in which indigenous people passed on their knowledge. By means of the question and answer method the educator sought information from the learners to find out from them what they know about the topic. The educator asked eight learners questions, who all responded. A limited attempt was made to brainstorm what was known about the topic.
	B. Identify personal	1. No opportunity was given to the	2	The educator asked eight learners out of a class

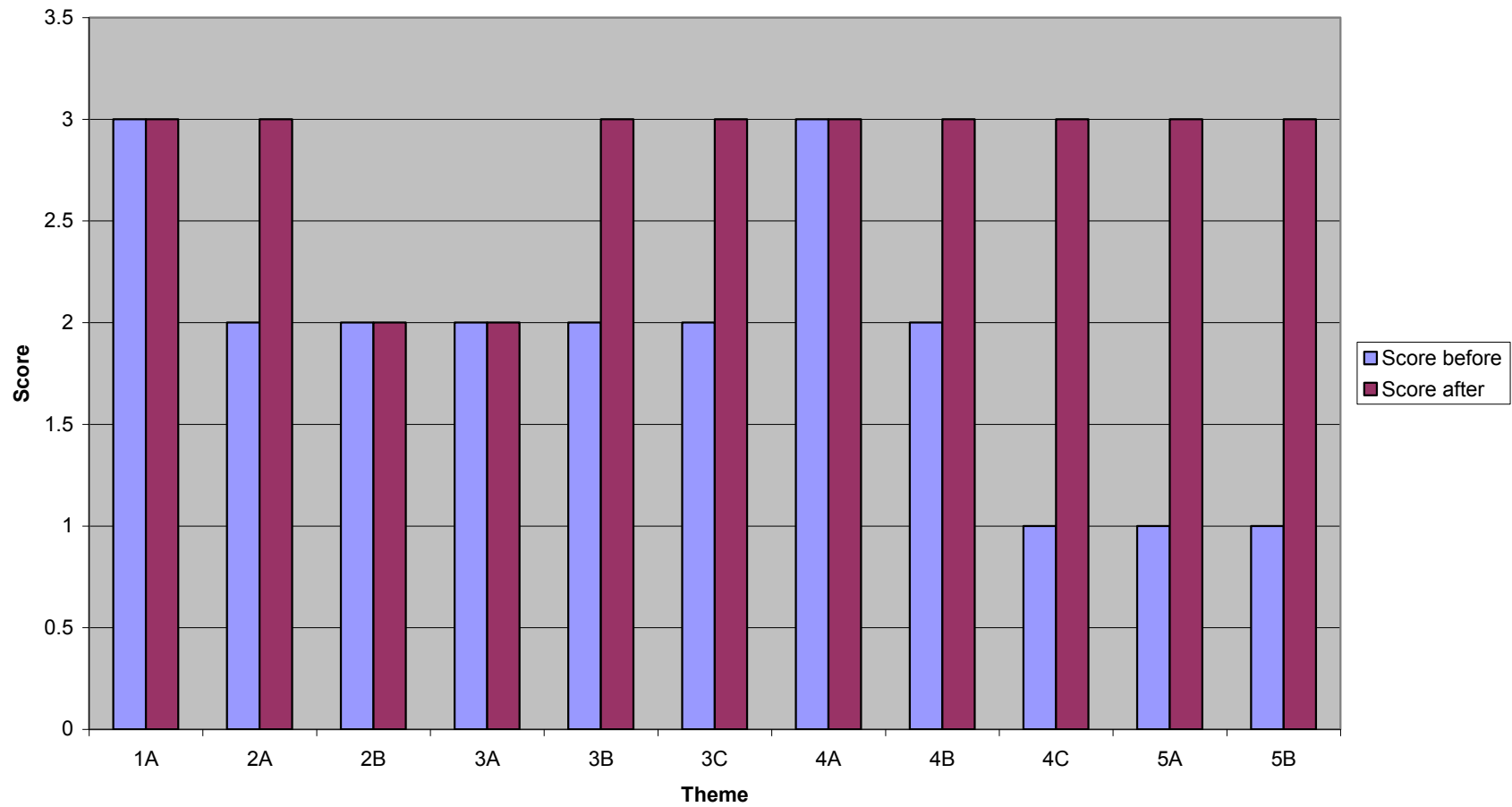
	ideas, beliefs and opinions.	<p>learners to express their personal ideas, beliefs and opinions.</p> <ol style="list-style-type: none"> 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs and opinions. 		of thirty three learner's questions about the two different perspectives. All the learners responded. Therefore the educator made a limited attempt for the learners to express their opinions.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The educator gave the learners a questionnaire which had to be completed individually. Some of the questions referred to western scientific knowledge and examples of western science. After completion of the questionnaire the learners then had to report back to the rest of the class. A class discussion followed after the feedback session. In this manner the learners engaged with the information from a western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	In their groups the learners discussed the indigenous knowledge perspective in a similar manner in which the western scientific perspective was discussed. In other words the learners had to answer a questionnaire individually. After completion of the questionnaire, the learners had to report back to rest of the class. The rest of the class then commented and gave feedback on the report of the learners.

	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No attempt was given to the learners to compare the two perspectives. 2. A limited attempt was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	3	As mentioned in the previous two discussions, the learners did compare the two perspectives. The learners compared the similarities and the differences between the two perspectives individually. They also had to mention two advantages and two disadvantages of western science and indigenous knowledge. After the learners completed the activity they had to report back to the rest of the class. After reporting back to the class, the learners gave feedback on what was reported by the rest of the class. In this manner opportunity was provided to the learners to compare the two perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective).	<ol style="list-style-type: none"> 1. No attempt was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	3	When the educator started the lesson he used the question and answer method to enquire what the learners knew about the topic. The learners were then divided into groups to discuss the two perspectives and they also had to give the advantages and disadvantages of each perspective. After the group discussions the learners reported back to the rest of the class. A further discussion then followed where the various perspectives which were provided by the different groups were discussed again. In this manner the learners were engaged in meaningful discussions to consider the consequence of each perspective.

	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept).	<ol style="list-style-type: none"> 1. No attempt was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives). 	3	The educator showed the learners various bottles of home remedies and explained to them what each one was used for. Then he explained to the learners that if they were sick they normally went to the doctor which was more expensive. The learners were shown that by combining the indigenous perspective with the western science can be useful. Then the learners were divided into groups where they had to give two advantages and two disadvantages of western science and indigenous knowledge. In this manner learners could develop their own understanding of synthesizing the two perspectives.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited opportunity was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were made to highlight the values and ethics associated with each perspective. 	3	After explaining the two perspectives to the class, the educator divided the class into groups where they had to explain what western science and IK was and to give two advantages and disadvantages of the two perspectives. After the group discussions, the learners gave feedback to the rest of the class. During the discussion that followed the educator provided the learners a worksheet of a case study of Pakistan. In the case study it was shown that big pharmaceutical companies were over-exploiting the medicinal plants for money. This led to over-grazing, soil erosion and deforestation. The values and ethics associated with each perspective were highlighted to the learners by the educator.
5. Evaluate the process.	A. Has the teacher checked whether there has been a	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two 	3	The learners compared the different perspectives. Opportunities that were provided by the educator included: the group

	shift in opinion about the two perspectives?	<p>perspectives.</p> <ol style="list-style-type: none"> 2. A limited opportunity was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were made to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 		<p>discussions where they had to complete a questionnaire. After completion of the group discussion the learners had to provide feedback to the rest of the class. Then a discussion followed of all the views that were expressed. The learners were then given a case study of Pakistan. After all these discussion the educator checked whether there was a shift in opinion about the two perspectives. This he did by asking questions to the learners.</p>
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited opportunity was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were made to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	3	<p>In the educator's explanation about comparing the western science with the indigenous knowledge, a comparison was made of how expensive it was of going to the doctor compared to using local knowledge. Using local knowledge was less expensive. Many learners did not believe the educator about the use of the home remedies. The educator showed the learners the jars of the medicines and asked some learners to read on the label of each flask what the home remedy was used for. Many learners then commented that they understood the local knowledge better and that they would use the local knowledge in future. Further opportunities that were provided to the learners to show their understanding of the different perspective was provided with the questionnaire as well as the case study.</p>

Summary of Mike's Scores



THABISA – Before training

NAME OF TEACHER: Thabisa

DATE: 14 October 2008

GRADE: 10

TOPIC: How African medicines are used to treat diseases

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic chosen was how African medicines were used to treat diseases. The chosen topic has an IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator started the lesson by asking six learners out of a class of thirty three learners questions about how cancer could be treated, and all the learners responding. Four learners were then asked to identify an example of African medicine, namely the African Potato. The educator made a limited attempt to brainstorm what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners	2	The educator introduced the topic to the learners. She then proceeded to ask nine learners questions on how a disease, namely cancer, could be treated. The learners mentioned how cancer could be treated by radiotherapy, chemo therapy, surgery as well as for example with <i>bucchu</i> or the African Potato. A limited opportunity was given to the learners

		to express their personal ideas, beliefs and opinions.		to express their personal ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	After the introduction to the lesson, the educator divided the class into groups . Each learner was provided with a worksheet . On this worksheet the learners had to explain what they understood by the term western scientific knowledge. After a few minutes each group had to report back on what they understood by the term western scientific knowledge. Adequate opportunity was provided to the learners to engage with the information.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The learners were divided into groups . In their groups the learners had to discuss what they understood by the term indigenous knowledge. After a few minutes a learner in each group had to report back to the class what they understood by the term indigenous knowledge. After each group completed their report back, a discussion followed. Adequate opportunity was provided to the learners to engage with the information.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were 	1	The educator started the lesson by asking the learners how cancer could be treated. She then asked the learners that if scientific knowledge was used, how cancer could be treated. The learners responded by giving examples on how cancer could be treated. The educator then explained to the class how IK was used to treat

		given to the learners to compare the two perspectives.		cancer, for example using the African Potato. However, the educator did not provide opportunity to the learners to compare the two perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	1	The educator divided the class into groups . In their respective groups the learners discussed what western science and IK meant. After the group discussion the learners had to report back to the rest of the class what they understood about the two perspectives. However, no opportunity was given to the learners to consider the consequence of each perspective.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were 	2	After the learners discussed the two perspectives in their groups, the educator gave the learners examples of plants that were used as medicines, for example <i>Ikhala</i> (Aloe) and <i>Umhlonyane</i> (wormwood) and what each one was used for as medicines. She then asked the learners if they knew of any one in their family who used the traditional medicine. One learner explained that their grandmother, who was a traditional healer, used a very special plant that

	application of the topic/concept.	given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		healed cancer. The educator did not give the learners opportunities to consider the consequences of each perspective.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	1	The educator first asked six learners questions on how cancer could be treated. The class was then divided into groups . In their groups the learners discussed the two perspectives, namely IK and western science. Each group then reported back to the rest of the class on their understanding of the two perspectives. The educator then showed examples of plants used as traditional medicines. The educator did not highlight the values and wisdom associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The educator first asked the learners questions on how cancer could be treated. The class was then divided into groups where the learners had to discuss what IK and scientific knowledge was. The learners were then shown examples of plants that could be used as traditional medicines. An explanation was then given to the learners what the plants were used for. The educator did not check whether there was a shift in opinion about the two perspectives.

	<p>B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)</p>	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	<p>After the group discussion, the educator gave an explanation of plants that was used as traditional medicine. There was also some feedback from learners on how their family members used the examples of plants that the educator has shown. However, the educator did not check whether there was a shift in opinion and whether the shift would inform future action. At the end of the lesson the educator only asked the learners to complete the activity for homework and to bring it back to school the following day.</p>
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THABISA – After training

NAME OF TEACHER: Thabisa

DATE: 23 October 2008

GRADE: 10

TOPIC: IK and its uses with regard to medicine

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic chosen was IK and its uses with regard to medicine. The chosen topic has a clear IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	3	The educator introduced the topic to the learners. A worksheet was given to the learners, who were all seated in groups . The learners were then asked to report their answers to the worksheet to the rest of the class. All the learners answered the questions with regard to the medicinal uses of plants. The learners showed a good understanding of the different plants and could explain what the name of the plant was, as well as what it was used for. After the report back by the learners, a discussion followed on the medicinal uses of plants. In this manner opportunity was provided to all learners to express their opinion on what was known about the topic.
	B. Identify personal ideas, beliefs and	1. No opportunity was given to the learners to express their personal	3	The learners were divided into groups where the teacher provided them with a question

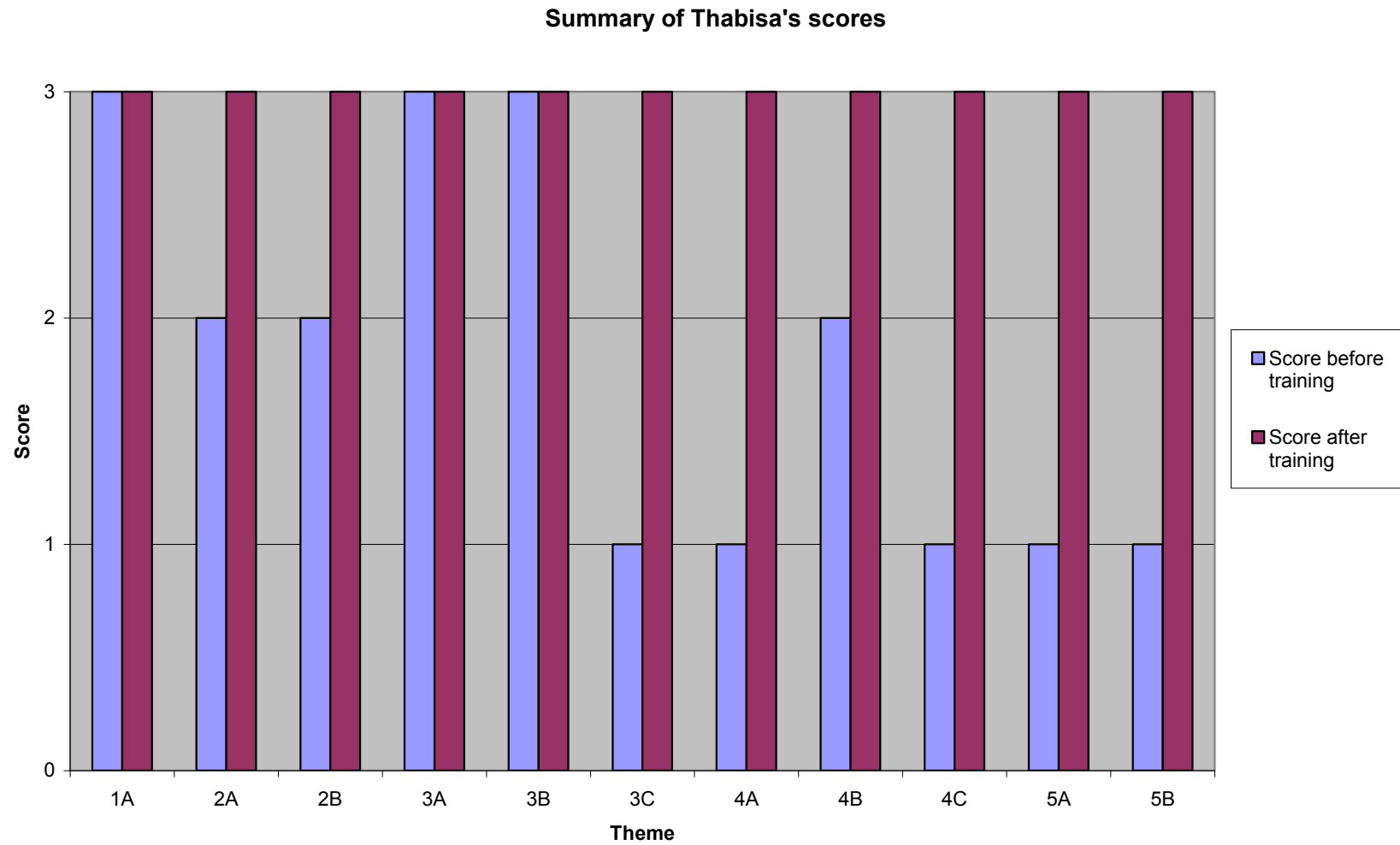
	opinions.	<p>ideas, beliefs and opinions.</p> <ol style="list-style-type: none"> 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs and opinions. 		<p>sheet. The learners in each group were asked to answer the questions and then to give feedback to the rest of the class. In each group a member had to provide the answers to a question. As the learners provided the answers, the educator repeated the answer and asked the rest of the class whether they agreed with the answer. In some cases the learners did not agree. A discussion then followed to explain to the learners the answer where there was disagreement. In this manner the personal opinion and ideas of the learners were identified.</p>
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	<p>The class was divided into groups. The educator gave a worksheet to the learners. In their groups the learners had to discuss what they understood about western scientific knowledge. As the learners reported back in their groups, the educator wrote down what was said by each group. A discussion then followed where other groups could add on to what was mentioned earlier. In this manner the learners were able to engage with the information.</p>
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge 	3	<p>As mentioned above, the learners had to discuss in their groups, about indigenous knowledge and scientific knowledge. After a discussion the learners gave a report back to the rest of the class. This was followed by another discussion amongst learners in the class. The educator then gave a worksheet with questions on medicinal plants to the learners. The learners then had to answer the questions and to give a report back</p>

		perspective (adequate references provided and opportunities were provided to the learners to engage with the information).		to the rest of the class. In this manner extensive reference was given to the indigenous perspective.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	3	The first worksheet which the learners had to complete was about indigenous knowledge and western scientific knowledge. The learners first explained what scientific knowledge was and then what indigenous knowledge was. As the learners explained their answers, the educator summarized what was being said on the blackboard. Opportunity was provided to the learners to compare the two perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	3	The learners were firstly provided with a worksheet which they had to complete in groups and then report back to the rest of the class. After the learners provided the answers, a discussion followed. The educator then provided the learners with a question sheet with questions regarding plants that were used as medicines. The learners completed the questions and then reported back to the rest of the class. This was followed by a discussion amongst the rest of the learners. The learners were engaging in meaningful discussion.
	B. Consider the	1. No opportunity was given to the	3	After the group discussion about scientific

	concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept).	<p>learners to synthesise the two perspectives.</p> <ol style="list-style-type: none"> 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives). 		<p>knowledge and indigenous knowledge, the learners were provided with a page with questions about how people have been using plants as medicines for thousands of years. The roles of traditional healers were discussed, as well as reasons why many patients, especially in the rural areas, visited traditional healers. Plants such as wild ginger have been traditionally used for the treatment of coughs and flu. It was then shown that modern medicines such as Panado and Flutex were used today for colds and flu. In his manner learners could develop their own understanding of synthesizing the two perspectives, and that each perspective was useful.</p>
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	3	<p>After completing the group discussion on the two perspectives, the educator provided the learners with questions about how people have been using plants to make medicines. A discussion followed where the educator explained how modern science and IK can both contribute to cure coughs and flu. The educator then asked the learners what the link between scientific knowledge and IK was. A discussion followed between the learners. Some learners provided answers which were disputed by other learners. For example one learner said that there was no measurement in IK. Other learners said that that was incorrect and gave an explanation on how measurement was done by their parents (which they considered as indigenous). By means of discussion, the values and ethics associated with each perspective was discussed</p>

				amongst the learners.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	3	<p>The learners had a group discussion on western science and indigenous knowledge. This was followed by a group discussion on the use of plants to make medicines. After the group discussion the educator explained to the learners what the between indigenous knowledge and western scientific knowledge was. During the discussion it was evident that there was disagreement amongst the learners. Some learners expressed the opinion that “the modernized people do not use plants for medicine.” A heated argument followed where eventually consensus was reached that that was not the case. The educator checked whether there was a shift in opinion about the two perspectives.</p>
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision 	3	<p>During the group discussions, as well as the classroom discussion, it became quite clear that there was misunderstanding of the two perspectives. Many of the learners was of the opinion that there were many differences between IK and western science. They mentioned that for example in IK there was no testing and in western science there was testing. It was also mentioned that the people do not use plants as medicines. But through discussion the learners had a clearer understanding of the two perspectives.</p>

		based on an appropriate scenario).		
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Ursula – First observation

NAME OF TEACHER: Ursula

DATE: 17 October 2008

GRADE: 10

TOPIC: How abiotic and biotic factors are used in rituals

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was how abiotic and biotic factors were used in rituals. The chosen topic has a clear IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By means of the question and answer method the educator attempted to find out what is known about the topic. She asked six learners out of a class of thirty five learners questions of examples of abiotic and biotic factors and all of them responded. A limited attempt was made to find out from the learners what they know about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners	1	After the introduction of the lesson, the educator skillfully used the question and answer method. Eight learners were asked questions of whom six responded. As the learners answered the questions, the educator wrote down the answers on the blackboard. However, no opportunity was given to the learners to express their own ideas. When the learners answered a

		to express their personal ideas, beliefs and opinions.		question which was not the answer that the educator wanted, she would guide the learners so that they could provide the answer she expected. For example the learners were asked how water was used in rituals. The learners were providing different examples, which according to the educator were not the expected answers. The educator then said: “I was thinking about Moslems who also use water in rituals. We know that they pray many times a day... especially when they are fasting they have to pray five times a day. And every time before they go to pray they must also wash themselves clean, like after a funeral as you have said. They also have a ritual where they wash their hands... wash their mouth... and as they do that they pray...so they also use water in their rituals.”
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	1	No reference was given to the western scientific perspective. The entire lesson was about the rituals performed by the different cultures.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to 	3	Extensive reference was given to the indigenous knowledge perspective. After the educator explained the purpose of the lesson, the learners were asked to list all the biotic and abiotic

		<p>the indigenous knowledge perspective (a brief verbal reference).</p> <p>3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information).</p>		<p>components. As the learners listed the components, the educator wrote down each component on the blackboard. After listing the factors, the educator asked the learners to explain how each of those factors was used in rituals. The learners mentioned the different rituals for example slaughtering of animals for weddings and funerals as well as water which was used to make African beer which was used for cleansing against bad spirits. After a brief explanation by the educator, the learners were asked to write an essay on the rituals and to report back to the class. After fifteen minutes the educator asked three learners to read what they wrote.</p>
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<p>1. No opportunity was given to the learners to compare the two perspectives.</p> <p>2. A limited opportunity was given to the learners to compare the two perspectives.</p> <p>3. Extensive opportunities were given to the learners to compare the two perspectives.</p>	1	<p>The lesson was about how abiotic and biotic components were used in rituals. The educator explained this lesson from an indigenous perspective. No reference was given to the western scientific perspective. Therefore no attempt was made by the educator to compare the two different perspectives.</p>
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<p>1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given).</p> <p>2. A limited opportunity was given to the learners to consider the consequences of the respective</p>	1	<p>The lesson started with the educator introducing the topic. By means of the question and answer method the educator explained how the abiotic and biotic components were use in rituals. The learners were then given an opportunity to engage with the information by writing an essay. The lesson ended when three learners read their essay. The educator only chose an indigenous perspective. Therefore no</p>

		<p>perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion)</p> <p>3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).</p>		<p>opportunity was provided to the learners to consider the consequences of the respective perspectives.</p>
	<p>B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.</p>	<p>1. No opportunity was given to the learners to synthesise the two perspectives.</p> <p>2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives).</p> <p>3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).</p>	1	<p>The lesson was only from an indigenous knowledge perspective. The educator did not concentrate on the western scientific perspective of abiotic and biotic components (natural resources). Therefore no opportunity was given to the learners to synthesise the two perspectives.</p>
	<p>C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each</p>	<p>1. No attempt was made to highlight the values and ethics associated with each perspective.</p> <p>2. A limited attempt was made to highlight the values and ethics associated with each perspective.</p> <p>3. Extensive opportunities were given to the learners to highlight the values and ethics associated</p>	1	<p>The educator introduced the topic of the lesson. By means of the question and answer method the educator proceeded to explain the lesson. As the lesson progressed the educator wrote a summary on the blackboard. When the lesson was completed, the educator asked the learners to write an essay on the use of natural resources in rituals. The lesson concluded when three learners gave feedback on what they wrote. The</p>

	perspective?)	with each perspective.		educator made no attempt to highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The educator did not check whether there was a shift in opinion about the two perspectives. As mentioned earlier, the lesson was only from an indigenous knowledge perspective. After completion of the lesson, the educator asked the learners to write an essay. She did not mention anything about a western scientific perspective. For example, was rituals only from a cultural perspective (in this instance Black) or do other cultures also have rituals?
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving 	1	Because the lesson was only from an indigenous perspective, and nothing was mentioned about a western scientific perspective, there could be no shift in opinion about the two perspectives. The educator therefore made no attempt to check whether the shift in opinion would inform future actions.

		them in an activity or the teacher invites them to make a decision based on an appropriate scenario).		
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Ursula – Second observation

NAME OF TEACHER: Ursula

DATE: 22 October 2008

GRADE: 10

TOPIC: Traditional healers

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was on traditional healers. The chosen topic has a clear IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By means of the question and answer method the educator attempted to find out what is known about the topic. She asked four learners out of a class of twenty eight learners to give examples of medicinal plants. All the learners responded. A limited attempt was made to find out from the learners what they know about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners	1	After the initial question and answer session, the educator then proceeded with the new lesson. Eight learners were asked questions and they all responded. As the learners answered the questions, the educator wrote the answers on the blackboard. However, no opportunity was given to the learners to express their own ideas.

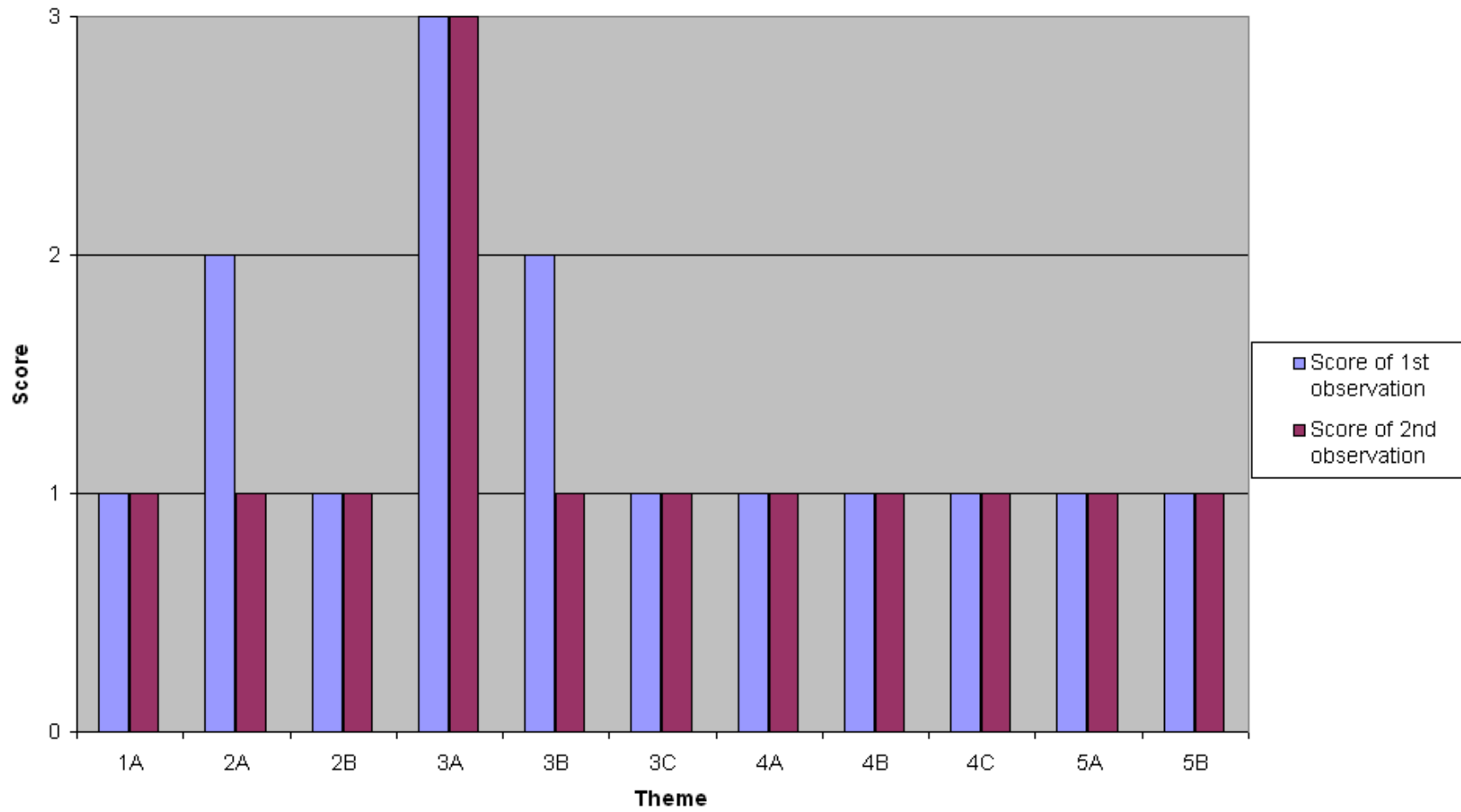
		to express their personal ideas, beliefs and opinions.		
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	The educator asked learners to give examples of medicinal plants. After a brief introduction, the educator asked the learners whether they preferred the traditional healers or the medical doctors. The educator divided the class into five groups where they had to discuss the traditional healers. When the learners gave their report back after the group discussions, two of the groups mentioned that medical doctors used technology and can do tests which traditional healers cannot do. However, no discussion followed on this aspect. A limited reference was therefore given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The lesson started with the educator explaining examples of medicinal plants. She then proceeded by asking questions to the whole class on what they knew about traditional healers. The class was then divided into five groups . In their groups the learners had to discuss what they knew about traditional healers. After ten minutes of the group discussions , each group had to report back to the rest of the class. As the learners gave their report back, the educator wrote a summary on the blackboard. After each group completed their report back, a discussion followed. Adequate opportunity was provided to the learners to engage with the information.
	C. Organize/ process the	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two 	1	The educator started the lesson by asking the learners to name examples of medicinal plants.

	perspectives by comparing them (similarities and differences).	<p>perspectives.</p> <ol style="list-style-type: none"> 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 		<p>She then explained about traditional healers. This was followed by a group discussion on traditional healers. In their report back the learners mentioned some differences between traditional healers (IK) and medical doctors (Western Science), for example medical doctors using technology and testing and can perform surgery whilst in the traditional healers it is not the case. However, the educator did not provide opportunities to compare the two perspectives.</p>
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	2	<p>The educator divided the class into five groups. In their respective groups the learners discussed traditional healers. After the group discussion, the learners had to report back to the rest of the class. Two of the groups said that they preferred medical doctors and provided reasons for example doctors are professional and technologically more advanced. The other three groups preferred traditional healers and provided reasons for example they are psychic because they can look at you and immediately say what is wrong with you and that they were connected to the ancestors. However, no opportunity was given to the learners to consider the consequences of each perspective.</p>
	B. Consider the concept or issues from a synthesis of perspectives (shows	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given 	2	<p>After the learners discussed the traditional healers in their groups, each group had to report back to the rest of the class. As the learners reported back, the educator wrote was being</p>

	that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		said on the blackboard. The educator informed the class that as a westerner she had learnt a lot during the lesson. She then asked the learners whether their opinion on traditional healers has changed. All of the learners said that their opinion has not changed and that they still believed in the traditional healers. However, one learner said that it was best to have two opinions, in other words to believe in traditional healers as well as the medical doctors.
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective.	1	The educator first asked learners to give examples of medicinal plants. The educator than explained about traditional healers. The class was then divided into five groups. In their groups the learners discussed traditional healers. Each group then reported back to the rest of the class on their understanding of traditional healers. A brief discussion followed after the report back. The educator than summarized the lesson. The two perspectives, namely IK (traditional healers) and Western science (medical doctors) were mentioned by the learners, but the educator did not highlight the value and wisdom associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks	2	The educator first asked the learners examples of medicinal plants. She then asked the learners whether they first went to the traditional healers, and if they were not cured, then they would go to the medical doctor. The learners were then divided into five groups where traditional healers were discussed amongst the learners. Each group then reported back to the

		<p>a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire).</p>		<p>class on their understanding of traditional healers and medical doctors. After the report back the educator summarized the lesson and said that everyone had learnt a lot during the lesson. She then asked the class whether their opinion on traditional healers had changed. In this manner a limited attempt was made by the educator to check whether there had been a shift in opinion about the two perspectives.</p>
	<p>B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)</p>	<p>1. No attempt was made to check whether the shift in opinion would inform future actions.</p> <p>2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario).</p>	1	<p>After the group discussion, the educator gave a summary of the lesson. She explained to the learners that she, as a westerner, has learnt a lot about traditional healers. However, the educator did not check whether there was a shift in opinion and whether the shift would inform future action. At the end of the lesson the educator only asked the learners to complete an essay, and to bring it back to school the following day.</p>

Summary of Ursula's Scores



Manelli- First observation

NAME OF TEACHER: Manelli

DATE: 17 October 2008

GRADE: 9

TOPIC: The separation of substances

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	1	The topic of the lesson was the separation of substances. The chosen topic has no IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic by explaining the aim of the lesson. By means of the question and answer method the educator sought information from the learners to enquire what they know about the topic. She asked questions to four learners out of a class of thirty learners, who all responded. A limited attempt was made by the educator to brainstorm what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions. 3. The teacher allowed the learners	1	After the initial question and answer session, the educator then proceeded with the new lesson. The educator explained the different methods to separate mixtures. This was followed by a demonstration of the different methods of separation. As the educator explained the lesson, she wrote a summary of what was said on the blackboard. No

		to express their personal ideas, beliefs and opinions.		opportunity was given to the learners to express their own opinions. The entire lesson was teacher-centered and the learners only listened as the educator talked .
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	The educator explained the different methods to separate mixtures. This was followed by a demonstration of the various methods to separate mixtures. A summary of what was said was written on the blackboard by the educator. No opportunities were provided by the educator for the learners to engage with the information. The entire lesson was from a western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	1	After explaining the different methods to separate substances, the educator then demonstrated how the different mixtures could be separated. No reference was given to the indigenous perspective and only the western scientific perspective was discussed.
	C. Organize/ process the perspectives by comparing them (similarities and	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two 	1	The lesson was about the different methods of separation of mixtures. The lesson was from a western scientific perspective. No reference was given to the indigenous perspective. Therefore no attempt was made by the educator to

	differences).	perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives.		compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).	1	The lesson started with the educator asking four learners to name examples of mixtures. Thereafter the educator explained how the mixtures are separated. The educator then demonstrated three ways in which mixtures could be separated. The lesson ended after the information was given to the learners. The educator only considered a western scientific perspective. No opportunity was provided to the learners to consider the consequences of the respective perspectives.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and	1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were	1	The lesson was only from a western scientific perspective. The educator did not inform the learners that there were indigenous ways to separate the mixtures. No opportunity was given to the learners to synthesise the two perspectives.

	application of the topic/concept.	given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	1	The educator explained separation of mixtures from a western scientific perspective. Not once during the lesson did the educator mention the indigenous perspective. For example, the whole class consisted of Black learners and all of them were aware of filtration during the brewing of <i>umqumbothi</i> (African beer). The educator did not attempt to highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The lesson was about separation of mixtures from a western scientific perspective. Not once during the lesson did the educator mention about the indigenous perspective. Therefore the educator could not check whether there was a shift in opinion about the two perspectives because the educator only concentrated on the western perspective.
	B. Has the teacher	1. No attempt was made to check	1	Because the lesson was only from a western

	checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<p>whether the shift in opinion would inform future actions.</p> <ol style="list-style-type: none"> 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 		scientific perspective, and nothing was mentioned about the indigenous perspective, there could be no shift in opinion about the two perspectives. The educator therefore could not check whether the shift in opinion would inform future actions.
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Manelli – Second observation

NAME OF TEACHER: Manelli

DATE: 22 October 2008

GRADE: 9

TOPIC: Biodiversity

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was biodiversity. The IK link became quite clear as the lesson unfolded because the lesson was about plants and its uses as medicines. There was a clear IK link to the topic.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By means of the question and answer method the educator sought information from the learners to enquire what they know about the topic. Questions were asked to six learners out of a class of thirty two learners, who all responded. A limited attempt was made by the educator to brainstorm what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs and opinions.	2	After the initial question and answer session, the educator introduced the new lesson to the learners. During the explanation of the new lesson, the educator again asked questions to the learners. Questions were asked to eight learners, who all responded. As the learners provided the answers, the educator wrote a

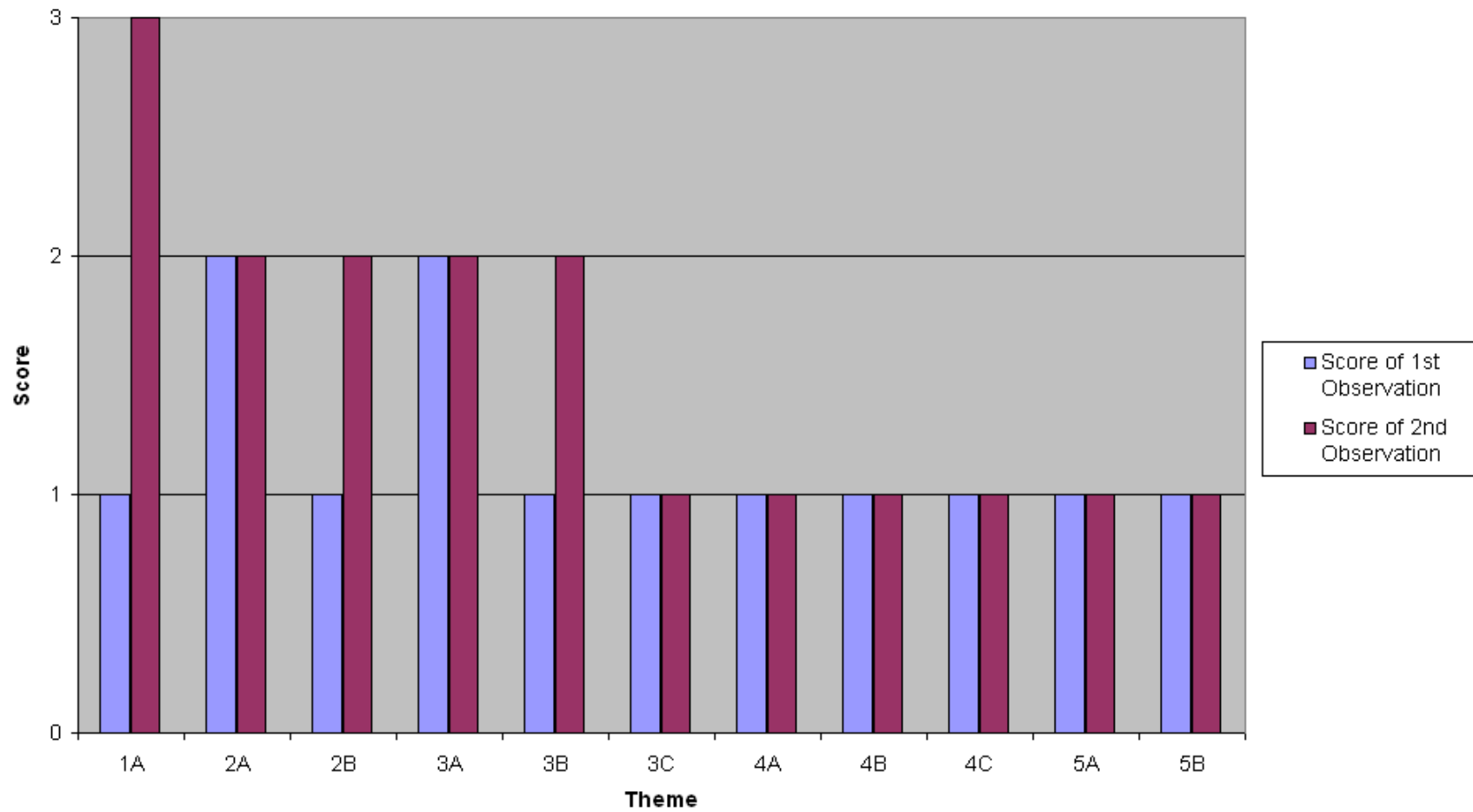
		3. The teacher allowed the learners to express their personal ideas, beliefs and opinions.		summary on the blackboard. However, no opportunity was given to the learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	The educator introduced the topic to the learners. By means of the question and answer method, the educator explained how plants were used for medicinal purposes. The educator did not mention anything about a western scientific perspective. However, one learner mentioned that he preferred medicines from the medical doctor, and not the traditional healers. The reason he preferred the medical doctors was because the traditional healers had no medicines for AIDS. Other than the brief verbal reference by the learner, no reference was given of the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	The educator explained the medicinal uses of plants. The educator explained that in Africa the traditional healers in rural areas mostly used the plants as medicines. The learners were then divided into five groups . A worksheet was given to the learners to discuss in their groups. The worksheet was about traditional healers. After ten minutes a learner in a group had to report back to the rest of the class. No discussion followed after the report back by the learners. The educator made a limited attempt to explain the indigenous perspective.
	C. Organize/ process the perspectives by comparing them	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given 	1	The lesson was about medicinal plants. The educator explained this lesson from an indigenous perspective. No reference was given to the western scientific perspective by the

	(similarities and differences).	to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives.		educator. Therefore no attempt was made by the educator to compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).	1	The lesson started with the educator asking the learners to name examples of plants that was used as medicines. Questions were asked to six learners who all responded. The learners provided examples of the medical plants and what they were used for; for example <i>umhlonyane</i> , which was used for the flu. Thereafter the educator explained the role of traditional healers and sangomas in the use of the medical plants. The learners were given an opportunity to engage with the information by discussing a worksheet in their groups. The lesson ended after each group reported back to the rest of the class. The educator only considered an indigenous knowledge perspective. No opportunity was provided to the learner consider the consequences of the respective perspectives.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better	1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives).	1	The lesson was only from an indigenous perspective. There was a brief verbal reference of medical doctors (Western Scientific perspective). But no opportunity was given to the learners to synthesise the two perspectives.

	understanding and application of the topic/concept.	3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		
	C. Consider the concept in view of values, ethics and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	1	The educator explained the medical use of plants by traditional healers and sangomas from an indigenous perspective. The Western perspective was only given a brief verbal reference. Therefore the educator did not highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The entire lesson was about medical plants and sangomas from an indigenous perspective. The educator could not check where there was a shift in opinion about the two perspectives because the educator only concentrated on the indigenous perspective.

	<p>B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)</p>	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	<p>Because the entire lesson was from an indigenous perspective, there could be no shift in opinion about the two perspectives. The educator could not check whether the shift in opinion would inform future actions.</p>
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Summary of Manelli's Scores



Jonas: First observation

NAME OF TEACHER: Jonas

DATE: 17 October 2008

GRADE: 9

TOPIC: The carbon cycle

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	1	The topic of the lesson was the carbon cycle. The chosen topic has no IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1) No attempt was made to brainstorm/gather learners' knowledge. 2) A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3) Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By the means of question and answer method, the educator attempted to find out what is known about the topic. She asked seven learners out of a class of thirty learners questions, who all responded. Therefore a limited attempt was made to find out from the learners what they know about the topic.
	B. Identify personal ideas, beliefs, and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions. 3. The teacher allowed the learners	1	After the initial question and answer session the educator then proceeded with the new lesson. Six learners were asked question and they all responded. As the learners answered the question, the educator wrote a summary on the blackboard. However, no opportunity was provided to the learners was provided to the learners to express their own ideas.

		to express their personal ideas, beliefs, and opinions.		
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The educator explained the carbon cycle to the learners. After the explanation, she demonstrated the carbon cycle using a picture as a teaching aid. The learners were then provided with a worksheet . The learners were divided into groups and asked to answer the questions. After ten minutes each group had to report back to the rest of the class. After each group reported back, the educator would ask the rest of the class whether they agreed with the answer. A discussion followed after each group reported back. Extensive reference was therefore given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	After the initial question and answer session, the educator proceeded with the new lesson. Using a worksheet, the educator explained the carbon cycle to the learners. The teacher then mentioned that in her culture indigenous (natural) plants were used by the sangomas to make medicines and therefore plants were very important in her culture. However, this point was not further discussed by the educator or the learners. A limited reference was therefore given to the indigenous perspective.
	C. Organize/ process the perspectives by comparing them	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given 	1	The lesson was about the carbon cycle. The educator explained this lesson from a Western scientific perspective. No reference was given to the indigenous perspective. Therefore no

	(similarities and differences).	to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives.		attempted was made by the educator to compare the two different perspective.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).	1	The lesson started with the educator asking learners questions of natural substances. By means of a worksheet the educator explained the carbon cycle. The learners were then given an opportunity to engage with the information by answering a worksheet in groups. Each group then reported back to the rest of the class. The lesson ended after the information was given to the learners. The educator only considered a Western Scientific perspective. Therefore no opportunity was provided to the learners to consider the consequences of the respective perspectives.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better	1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives).	1	The lesson was only from a western scientific perspective. A brief verbal reference was given to the indigenous perspective when the educator mentioned that in her culture plants were important. However, no discussion followed on the indigenous perspective and therefore no opportunity was given to the learners to synthesise the two perspectives.

	understanding and application of the topic/concept.	3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	1	The educator first asked the learners to give examples of natural substances. The educator then explained the carbon cycle. The class was then divided into five groups. In their groups the learners had to discuss a worksheet with questions. Each group then had to report back to the rest of the class. A brief discussion followed after each group delivered their report back. The entire lesson was from a western scientific perspective. There was a brief verbal reference of the indigenous perspective. However, the educator did not highlight the values and wisdom associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are 	1	The entire lesson was about the carbon cycle from a western scientific perspective. The entire could not check whether there was a shift in opinion about the two perspectives.

		engaged through class/group discussion or group/personal questionnaire).		
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	Because the entire lesson was from a western scientific perspective, there could be no shift in opinion about the two perspectives. Therefore the educator could not check whether the shift in opinion would inform future actions.

Jonas – Second Observation

NAME OF TEACHER: Jonas

DATE: 28 October 2008

GRADE: 9

TOPIC: Light

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	1	The topic of the lesson was light. The chosen topic has no IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	1	The educator introduced the topic to the learners. She then divided the class into seven groups and supplied each group with a glass beaker filled with water. The learners then conducted two experiments. The educator also provided the learners with a clean sheet of paper on which they had to record their observations. The educator made no attempt to find out from the learners what they know about the topic.
	B. Identify personal ideas, beliefs, and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions.	1	After the introduction of the topic by the educator, the class was divided into seven groups. The learners were then provided with a glass beaker with water. The learners had to conduct two experiments. The learners had to write down their observations and discuss it in their groups. Thereafter the educator asked each

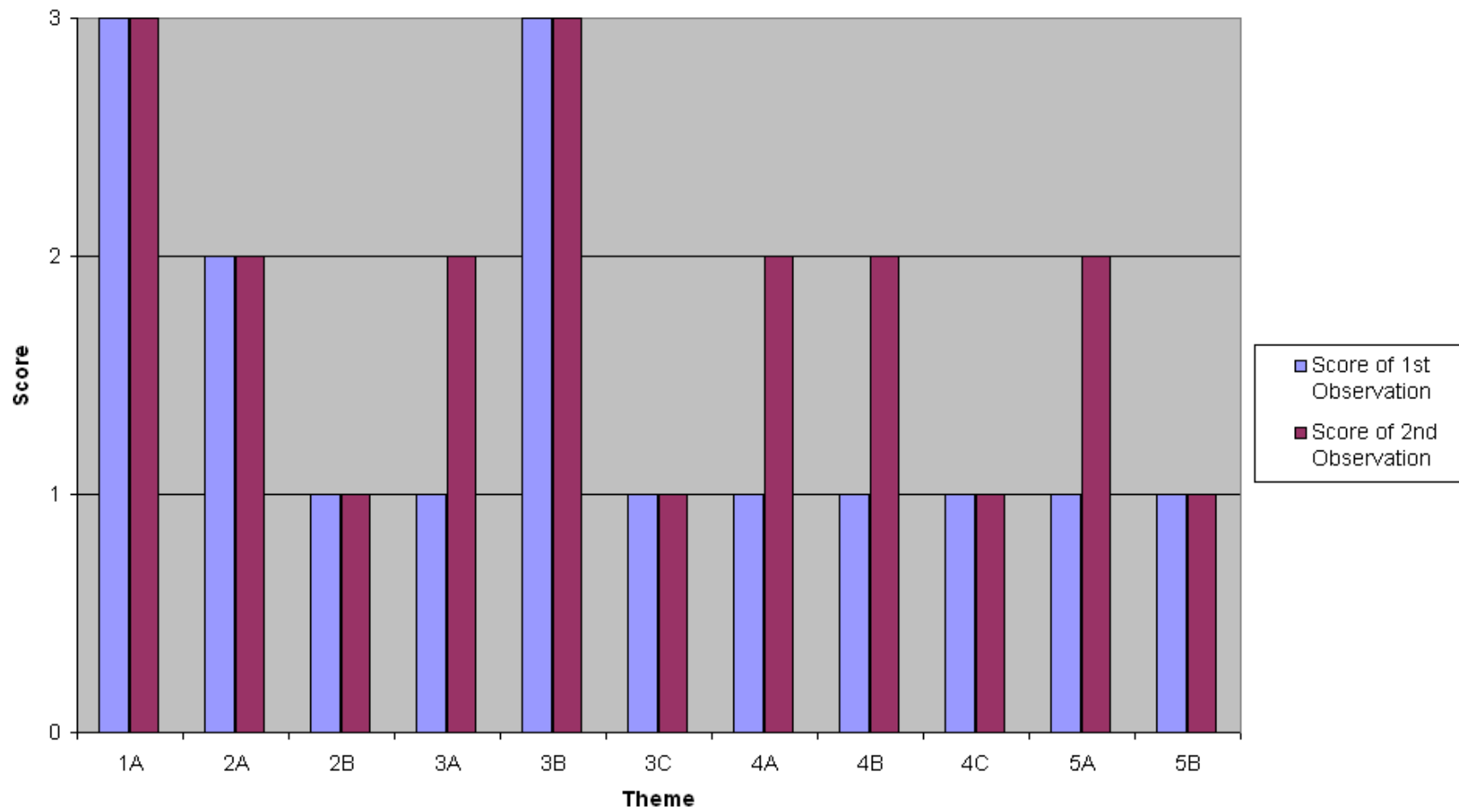
		3. The teacher allowed the learners to express their personal ideas, beliefs, and opinions.		group to report their observations to the rest of the class. As the learners provided the answers, the educator wrote down a summary on the black board. However, no opportunity was given to the learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The educator explained the topic to the learners. She then divided the class into seven groups . The learners then conducted two experiments. The learners had to record their observations and discuss their observations in their groups. When the learners reported back to the rest of the class, the educator explained the observations to the rest of the class. The explanations of the educator were about the incident ray and the reflected ray, as well as the role of water as a natural resource. The educator explained to the learners that what they were doing was what scientists was doing, namely to experiment. Extensive reference was therefore given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	1	As the learners were conducting their experiments, the educator assisted the different groups. The learners also discussed their observations amongst themselves. They then had to report back to the rest of the class. However, no reference was given to the indigenous perspective, and only the western scientific perspective was discussed.

	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	1	The lesson was about light. The educator explained this lesson from a western scientific perspective. No reference was given to the indigenous perspective. All the learners were Black and in their culture there were many examples where the aspect of light is explained. Therefore no attempt was made by the educator to compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	1	The lesson started with the educator introducing the topic to the learners. The class was then divided into seven groups. The groups were then provided with apparatus to conduct two experiments. The learners had to record their observations. Thereafter the learners had to discuss amongst themselves their observations, and then report back to the rest of the class. The educator only considered a western scientific perspective. Therefore no opportunity was provided to the learners to consider the consequences of each perspective.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the 	1	The lesson was only from a western scientific perspective. The educator did not inform the learners about the indigenous perspective of light. There are many cultural aspects of light. Therefore no opportunity was given to the

	perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		learners to synthesise the two perspectives.
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective.	1	The educator explained light from a western scientific perspective. No reference was given to the indigenous perspective. Therefore the educator did not highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are	1	The entire lesson was about light from a western scientific perspective. The educator could not check if there was a shift in opinion about the two perspectives because the educator only concentrated on the western scientific perspective

		engaged through class/group discussion or group/personal questionnaire).		
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	Because the entire lesson was from a western scientific perspective, there could be no shift in opinion about the two perspectives. Therefore the educator could not check whether the shift in opinion would inform future actions.

Summary of Jonas's Scores



Bradley: First and final observation

NAME OF TEACHER: Bradley

DATE: 17 October 2008

GRADE: 11

TOPIC: The structure of the eye and biodiversity

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	2	The topic of the lesson was the structure of the eye and biodiversity. The chosen topic has no IK link. However, as the lesson progressed, the educator asked the learners to name home remedies to treat diseases of the eye. The educator also discussed biodiversity with regard to sustainability and protection of medicinal plants. Therefore the chosen topic had a vague link to IK.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	After the educator introduced the topic, he asked the learners to open their notebooks and to look at their notes. He asked six learners out of a class of thirty seven learners question about the structure of the eye. All the learners responded. By means of the question and answer method the educator attempted to find out what is known about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions.	1	The educator first asked six learners questions on the eye. The educator then opened the notes on the screen about the structure of the eye. He

		<ol style="list-style-type: none"> 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs, and opinions. 		then asked four learners questions, who all responded. An activity was then shown on the screen and the educator asked a learner to complete the activity on the board. The educator then distributed questions on the eye to the learners, who had to complete the questions individually. No opportunity was given to the learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The educator introduced the topic to the learners. By means of the question and answer method the educator explained the structure as well as the function of the eye, for example papillary mechanism. The learners were then provided with an activity which they had to complete individually. After completion of the activity, the learners were asked to provide the answers to the questions. A discussion followed amongst the learners, because one of the learners provided an answer that was disputed by the rest of the class. With the assistance of the teacher the correct answers were derived at. Extensive reference was therefore given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge 	3	The educator asked the class what IK was. Five learners of the class of thirty seven learners provided answers for what IK was. The educator then divided the class into six groups . The learners had to discuss, in their groups, home remedies that were used for the treatment of diseases of the eye, namely sty and conjunctivitis. After a few minutes of discussion in their groups, the teacher asked

		perspective (adequate references provided and opportunities were provided to the learners to engage with the information).		each group to provide one example of treatment for each of the diseases. Answers were provided by each group, and a discussion followed. The teacher then provided the learners with a page, namely Protecting IK systems and Project to protect medicinal plants. The learners were then asked to answer the questions on the page in their groups. After ten minutes had to provide their answers to the rest of the class. As a group provided their answers, a short discussion followed. The teacher then explained the concept sustainability and the traditional healers and sangomas who exploited the environment. Extensive reference was given to the indigenous knowledge perspective.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	1	The western perspective, namely the structure and function of the eye was discussed. The educator then brought in the indigenous perspective, by asking the learners to mention examples of home remedies that was used in the treatment of diseases of the eye. However, no attempt was made by the educator to compare the two perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective 	1	The educator explained the structure and functions of the eye by means of the question and answer method. The learners were then given an opportunity to engage with the information by means of an activity. After completion of the activity the teacher introduced the concept of IK to the learners. The learners were then divided into groups and had to discuss home remedies that could be

		<p>perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion)</p> <p>3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).</p>		<p>used for the treatment of two diseases of the eyes, namely sty and conjunctivitis. Each group provided examples of home remedies, for example, tea bags for conjunctivitis and a nappy that the baby had urinated on for sty. The teacher then provided examples to the class which he found on the internet. The lesson ended after the information was given to the learners. No opportunity was provided to the learners to consider the consequences of the respective perspectives.</p>
	<p>B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept).</p>	<p>1. No opportunity was given to the learners to synthesise the two perspectives.</p> <p>2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives).</p> <p>3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).</p>	1	<p>The lesson was from a western scientific as well as an IK perspective. After the learners gave examples of home remedies that was used for the treatment of eye diseases, the teacher informed the class that he did not use home remedies and that he just goes to the doctor. No comparison was made of the two perspectives, and no opportunity was provided to the learners to synthesise the two perspectives.</p>
	<p>C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated</p>	<p>1. No attempt was made to highlight the values and ethics associated with each perspective.</p> <p>2. A limited attempt was made to highlight the values and ethics associated with each perspective.</p> <p>3. Extensive opportunities were given to the learners to highlight</p>	2	<p>The educator first explained the structure and functions of the eye. The learners then completed an activity on the structure of the eye. The learners were then given a question paper, where the learners had to answer the questions individually. A discussion followed after the learners provided the answers. The educator then introduced the concept of IK to</p>

	with each perspective?)	the values and ethics associated with each perspective.		the learners. The learners were the divided into groups. In their groups the learners had to discuss home remedies that were used in the treatment of eye diseases. A western and indigenous perspective of the eye was discussed by the learners. The learners discussed in their groups sustainability. Afterwards the teacher asked the learners to provide examples of over-exploitation in South Africa. The teacher then mentioned how Hoodia was exploited. The teacher also explained how traditional healers and sangomas exploited the environment. In this manner a limited attempt was made by the teacher to highlight values and ethics associated with the various perspectives, without providing the leaders opportunities to discuss it.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The educator asked the learners to discuss, in their groups, home remedies (IK) that was used for the treatment of diseases of the eye. After the discussions, the groups reported back to the rest of the class. The educator then informed the class that he did not use home remedies, but went to the doctor (western science). There was no discussion to check whether the learners that used home remedies (IK) would maybe prefer the medical doctor (western science) or vice versa. The educator did not check whether there was a shift in opinion about the two perspectives.

	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	<p>As mentioned in the previous section, the educator did not check whether there was a shift in opinion about the two perspectives. Therefore the educator could not check whether the shift in opinion would inform future actions, for example whether they would prefer the use of home remedies or go to the medical doctor.</p>

Sutwana- First and final observation

NAME OF TEACHER: Sutwana

DATE: 28 October 2008

GRADE: 11

TOPIC: Waves

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	1	The topic of the lesson was waves. The chosen topic has no IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The teacher introduced the topic to the learners. By means of the question and answer method the educator sought information from the learners to enquire what they knew about the topic. Questions were asked to seven learners out of a class of forty learners, who all responded. A limited attempt was made by the teacher to brainstorm what is known about the topic.
	B. Identify personal ideas, beliefs, and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions. 3. The teacher allowed the learners	1	After the introduction of the topic, the teacher proceeded with the day's lesson. Twelve learners out of the class of forty were asked questions, of whom ten responded. During the explanation of the new lesson, the educator again used the question and answer method, all the time writing a summary on the blackboard. However, no opportunity was given to the

		to express their personal ideas, beliefs, and opinions.		learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	<p>The educator explained what a wave was and gave characteristics of a wave. When she asked a learner what a wave was, the learner described the wave. But the educator said that she did not want the English name, but that she wanted the scientific names. The teacher then gave a demonstration on how waves were formed and compressed. As the teacher proceeded in giving examples of waves, she wrote a summary on the blackboard. She then called two learners to the blackboard to identify the parts of the wave, and to label the frequency of the wave. The educator then explained by means of formulas how the speed and velocity of the waves could be calculated. The educator explained how units were used and then wrote an example on the blackboard. She then asked the learners to complete the examples in their notebook. As the learners completed the example individually, the teacher went around the class and assisted the learners. Four learners were then asked to complete the examples on the blackboard. After the learners completed the examples, the teacher then explained the answers to the rest of the class. At the end of the lesson she asked the learners to complete some more examples for homework. Extensive reference was therefore given to the western scientific perspective.</p>
	B. Research the various indigenous	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge 	1	<p>After explaining the characteristics of waves, the educator explained how the speed and</p>

	perspectives	<p>perspective.</p> <ol style="list-style-type: none"> 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 		velocity of the waves could be calculated. The lesson ended after the information was given to the learners. No reference was given to the indigenous perspective, and only the western perspective was discussed.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	1	The lesson was about waves. The educator explained this lesson from a western scientific perspective. No reference was given to the indigenous perspective. Therefore no attempt was made by the educator to compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 	1	The lesson started with the educator asking the learners questions about waves. As the lesson proceeded, , the educator asked questions and the learners responding. The learners were then given an opportunity to engage with the information by answering an exercise in their notebook. The lesson ended after the information was given to the learners. The educator only considered a western scientific perspective and no reference was made about the indigenous perspective. Therefore no opportunity was provided to the learners to consider the consequences of the respective

		3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).		perspectives.
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives). 	1	The lesson was only from a western scientific perspective. No reference was made of the indigenous perspective. Therefore no attempt was made by the educator to compare the two different perspectives.
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective. 	1	The educator explained waves from a western scientific perspective. Not once during the lesson did the educator mention the indigenous perspective. The educator did not attempt to highlight the values and ethics associated with each perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a	1. No attempt was made to check whether there has been a shift in the opinions about the two	1	The lesson was about the characteristics of waves, as well as the structure of waves in general. This lesson was taught from a western

	<p>shift in opinion about the two perspectives?</p>	<p>perspectives.</p> <ol style="list-style-type: none"> 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 		<p>scientific perspective. Not once during the lesson did the educator mention the indigenous perspective. Therefore the educator could not check whether there was a shift in opinion about the two perspectives.</p>
	<p>B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)</p>	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	<p>Because the lesson was only from a western scientific perspective, and nothing was mentioned about the indigenous perspective, there could be no shift in opinion about the two perspectives. The educator therefore could not check whether the shift in opinion would inform future actions.</p>

Wayne: First and final observation

NAME OF TEACHER: Wayne

DATE: 17 October 2008

GRADE: 9

TOPIC: Nutrition in plants

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	2	The topic of the lesson was nutrition in plants. The chosen topic has no IK link. However, as the lesson unfolded, the educator asked the learners what certain herbs was used for at their homes. In this manner the educator enquired about their local knowledge. Therefore the chosen topic had a vague IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. By the means of question and answer method, the educator skillfully sought information from the learners to enquire from them what is known about the topic. Questions were asked to eleven learners from a class of thirty eight learners, who all responded. A limited attempted was made by the educator to find out from the learners what they know about the topic.
	B. Identify personal ideas, beliefs and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions.	2	By means of the question and answer method the educator then proceeded with the new lesson. Six learners were asked question and

		<ol style="list-style-type: none"> 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions. 3. The teacher allowed the learners to express their personal ideas, beliefs, and opinions. 		they all responded. As the learners answered the question, the educator wrote a summary on the blackboard. However, no opportunity was provided to the learners was provided to the learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	<p>The teacher introduced the topic to the learners. The teacher then showed a jar with cloves in it to the learners. By means of the question and answer method the teacher explained how all the herbs spices came from plants. The teacher then used the overhead projector to show a transparency depicting an experiment on how plants grew. After an explanation of van Helmonds experiment, the educator showed a drawing of a plant on the overhead projector. By means of the question and answer method the educator completed the picture on the overhead projector. He asked the learners questions, and as they responded he wrote the answers on the transparency. The educator showed the learners van Helmond's experiment in the textbook. The educator explained that another scientist, namely Priestly took van Helmond's experiment further and found that plants also needed oxygen and carbon dioxide in order for them to live. The teacher then handed out a worksheet. He asked the learners to use the worksheet and to copy down the notes from the transparency. They had to write down the names of oxygen and carbon dioxide, as well as their symbols on the paper and to put</p>

				the worksheet in their notebook. Extensive reference was therefore given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	<p>After the teacher explained the experiments of van Helmond and Priestly, the learners completed a worksheet. The teacher then showed the learners a packet with wormwood. He asked a learner what wormwood was for. Four learners gave functions of wormwood, for example to use it if your stomach cramps. The educator asked the learners how they knew that the wormwood could be used to treat many different kinds of illnesses. The learners said that their parents and grandparents told them. The learners then mentioned about Rastafarians who go into the mountain to fetch plants. The educator explained that the knowledge was passed on from their grandparents to their parents and their parents passed the knowledge on to them. The educator went on to explain that sometimes the knowledge can be passed on wrongly. Extensive reference was therefore given to the indigenous knowledge perspective.</p>
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	1	<p>The educator first showed the learners jars containing herbs and spices. He asked the learners to identify what was in the jars and what it was used for. The educator then explained the experiments of van Helmond and priestly. A worksheet was then given to the learners to complete. The lesson at this stage represented a western scientific perspective. The educator then showed the learners a wormwood branch, and asked the learners to</p>

				identify it. All the learners in the class identified the wormwood and mentioned functions of wormwood. By means of the question and answer method the educator explained the indigenous perspective. However, no opportunity was provided to the learners to compare the two perspectives. The educator only mentioned that if you went to the doctor, the doctor will not ask you to drink the liquid that was brewed from the wormwood tree.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	1	The educator showed the learners jars and asked questions to the learners, who responded. He then explained two experiments to the class and asked them to complete a worksheet. The educator then explained how our parents and grandparents passed on information orally. But the knowledge is now being lost because their parents did not tell them everything, and that many grandparents are now dead with their knowledge. The lesson ended after the information was given to the learners. No opportunity was provided to the learners to consider the consequences of the respective perspectives.
	B. Consider the concept or issues from a synthesis of perspectives (shows	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given 	2	The educator asked the learners to identify the wormwood branch. All the learners identified the wormwood and mentioned functions of wormwood. The educator then mentioned to the

	that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<p>to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives).</p> <p>3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).</p>		<p>learners that if they went to a medical doctor, then the doctor will not tell them to use wormwood. The educator then told the learners that we are told that cancer is incurable. But amongst people in Africa there is a believe that there is a herb, which will, if you use it, can cure cancer. If you go to the hospital, they use chemo-therapy. But then your hair falls out. Therefore, by using indigenous knowledge and western science, cancer can be treated. A limited opportunity was given to the learners to synthesise the two perspectives.</p>
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	<p>1. No attempt was made to highlight the values and ethics associated with each perspective.</p> <p>2. A limited attempt was made to highlight the values and ethics associated with each perspective.</p> <p>3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective.</p>	1	<p>The educator explained the experiments of van Helmond and Priestly, which represented a western scientific perspective. The educator then explained that our parents and grandparents used home remedies to treat diseases. This knowledge was passed on to our parents who now passé it on to us. However, the educator did not highlight the values and ethics associated with each perspective.</p>
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<p>1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives.</p> <p>2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check</p>	1	<p>The educator gave a western scientific perspective on how plants made food. The educator proceeded to explain how home remedies were used for the treatment of diseases, in other words the indigenous perspective. The lesson ended after the information was given to the learners. The educator did not check whether there was a shift in opinion about the two perspectives.</p>

		whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire).		
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	As mentioned in the previous section, the educator did not check whether there was a shift in opinion about the two perspectives. Therefore the educator could not check whether the shift in opinion would inform future actions.

Gareth- First and final observation

NAME OF TEACHER: Gareth

DATE: 28 October 2008

GRADE: 11

TOPIC: Biodiversity

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was biodiversity. The chosen topic has an IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. The teacher asked questions to the class in general and not to any specific learner. By means of the question and answer method the teacher attempted to find out what is known about the topic.
	B. Identify personal ideas, beliefs, and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal ideas, beliefs, and opinions.	1	After the initial question and answer session to revise the previous day's work, the educator then proceeded with the new lesson. The educator again asked questions to the class in general. Five questions were asked to the class. On two occasions there were no response from any learner, and the teacher showed the answer

		3. The teacher allowed the learners to express their personal ideas, beliefs, and opinions.		on the board. However, no opportunity was given to the learners to express their own ideas.
3. Research the various perspectives.	A. Research the western science perspective.	<ol style="list-style-type: none"> 1. No reference was given to the western scientific perspective. 2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	2	The educator explained the concept biodiversity to the class. The educator then explained the importance of biodiversity, in other words, how the biological resources contribute to the well-being of humans. The educator explained that the plants and animals must be taken care of and to preserve it for future generations. The educator then explained about the Hoodia plant which was used by the San people as an appetite suppressant. The educator then explained how Pfizer, the international pharmaceutical giant, began to work on the appetite suppressant from the Hoodia plant. These Big Corporations represented western science who hoped to make huge amounts of money. A limited reference was given to the western scientific perspective.
	B. Research the various indigenous perspectives	<ol style="list-style-type: none"> 1. No reference was given to the indigenous knowledge perspective. 2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference). 3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information). 	3	The educator explained the concept biodiversity as well as the importance of biodiversity. The educator then explained how the San people, who were very traditional people, practiced the same customs today which they have had for many generations. The educator then explained how the San people used the Hoodia plant as an appetite suppressant and thirst quencher. After a lengthy explanation about the Hoodia plant, the educator gave the learners an activity which they had to complete individually. After the learners completed the activity, the educator

				asked the learners randomly to answer the questions. As a learner answered a question, a discussion followed amongst the learners. Extensive reference was given to the indigenous perspective.
	C. Organize/ process the perspectives by comparing them (similarities and differences).	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to compare the two perspectives. 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 	2	After the introductory explanation about the Hoodia plant, the educator explained how the big pharmaceutical corporations for example Pfizer exploited the Hoodia plant and benefited from this plant because they were making money. The learners were then given an activity where they had to answer questions in their notebooks. After the completion of the activity a discussion followed. The learners had to compare the pharmaceutical company and how the San people were affected. A limited attempt was made by the educator to compare the two different perspectives.
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider 	2	The educator explained how the pharmaceutical companies like Pfizer benefited from the Hoodia plant. An activity was given to the learners to complete in their notebooks. The learners reported their answers to the rest of the class, they mentioned about groups of people who could benefit from plant, for example people who were overweight, people who were training, etc. However, there was no discussion comparing the two perspectives. A limited opportunity was provided to the learners to consider the consequences of each perspective.

		the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion).		
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that knowledge of each makes for a better understanding and application of the topic/concept.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives). 	2	The educator explained the importance of biodiversity. Then the educator explained how the Hoodia plant was used by the San people as a hunger suppressant. The manner in which the pharmaceutical companies exploited the Hoodia plant was then highlighted by the educator. The learners were then given an activity to complete in their notebooks. A discussion followed as the learners were explaining their answers to the rest of the class. What was clear in the discussion was that each perspective was useful and that an understanding of each perspective made for a better understanding of each perspective. For example, the San people benefited, as well as the pharmaceutical companies. However, both groups may also be disadvantaged. The example given was that if there were no more Hoodia plants, because of overexploitation, then both groups lose out. The learners then mentioned measures that may be implemented to protect the plant. Opportunity was given to the learners to synthesise the two perspectives.
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight	<ol style="list-style-type: none"> 1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 	2	When the learners complete the activity, they had to provide their answers to the rest of the class. When the learners were answering the questions, the teacher noted that in all the cases the learners were only interested in the financial aspect and how a profit could be made. The

	the values and ethics associated with each perspective?)	3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective.		educator highlighted the fact that mankind only worry about making money but that they forgot about the wealth of our biodiversity for future generations. To illustrate this fact the teacher showed the following equation from the Cree Indian Philosophy on the screen, namely: Only after the last tree has been cut down, only after the last river has been poisoned, only after the last fish has been caught, only then will you find out that money cannot be eaten. The values and ethics associated with each perspective were highlighted to the learners by the teacher.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	<ol style="list-style-type: none"> 1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal questionnaire). 	1	The teacher explained the concept biodiversity. Then he explained how the San people used the Hoodia plant as a hunger suppressant and thirst quencher on their hunting trips. The role of the pharmaceutical companies like Pfizer was highlighted. These companies exploited the Hoodia, making huge profits. The learners were then given an activity to complete in their notebooks. After ten minutes the lessons reported their answers back to the rest of the class, followed by a discussion. The lesson ended after the information was given to them. The educator did not check if there was a shift in opinion about the two perspectives.
	B. Has the teacher checked how the shift in opinion	1. No attempt was made to check whether the shift in opinion would inform future actions.	1	As mentioned in the previous section, the educator did not check whether there was a shift in opinion about the two perspectives.

	would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<p>2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners).</p> <p>3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario).</p>		Therefore the teacher could not check whether the shift in opinion would inform future actions.
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Charles- First and final observation

NAME OF TEACHER: Charles

DATE: 28 October 2008

GRADE: 11

TOPIC: Indigenous knowledge and medicinal plants

STEP	THEME	INDICATOR	NO.	EVIDENCE
1. Choose a topic or Science concept.	A. Is there a link between the concept chosen and IK?	1. No IK link to the topic. 2. Vague IK link to the topic. 3. Clear IK link to the topic.	3	The topic of the lesson was indigenous knowledge and medicinal plants. The chosen topic has an IK link.
2. Identify personal knowledge.	A. Brainstorm what is known about the topic.	1. No attempt was made to brainstorm/gather learners' knowledge. 2. A limited attempt (i.e. of only 10% of learners) was made to brainstorm/gather learners' knowledge. 3. Opportunity was given for all opinions to be expressed.	2	The educator introduced the topic to the learners. The teacher asked questions to the class in general and not to any specific learner. He asked the class what they understood by the term indigenous. Two learners out of a class of twenty four learners responded (incorrectly). The teacher then read to class a few definitions on what indigenous was. The teacher made a limited attempt to find out what is known about the topic.
	B. Identify personal ideas, beliefs, and opinions.	1. No opportunity was given to the learners to express their personal ideas, beliefs, and opinions. 2. A limited opportunity (i.e. of only 10% of learners) was given to the learners to express their personal	3	The teacher introduced the topic to the class and asked tow questions to the class. Two learners responded. The teacher then divided the class into six groups of four learners each. The teacher then asked the learners to discuss in their groups three indigenous South African

		<p>ideas, beliefs, and opinions.</p> <p>3. The teacher allowed the learners to express their personal ideas, beliefs, and opinions.</p>		<p>plants that were already used with economic success and to state the medicinal use of each plant. After the learners discussed the questions in their groups, they reported their answers to the rest of the class. In this manner the personal opinion and ideas of the learners were identified.</p>
3. Research the various perspectives.	A. Research the western science perspective.	<p>1. No reference was given to the western scientific perspective.</p> <p>2. A limited reference was given to the western scientific perspective (i.e. a brief verbal reference).</p> <p>3. Extensive reference was given to the western scientific perspective (adequate references provided and opportunities were provided to the learners to engage with the information).</p>	1	<p>The teacher introduced the topic of the lesson. By means of the question and answer method the teacher sought to find out from the learners what they knew about the topic. The class was then divided into groups. In their groups the learners had to identify three indigenous plants and discuss the medicinal aspects of it. No reference was given to the western scientific perspective.</p>
	B. Research the various indigenous perspectives	<p>1. No reference was given to the indigenous knowledge perspective.</p> <p>2. A limited reference was given to the indigenous knowledge perspective (i.e. a brief verbal reference).</p> <p>3. Extensive reference was given to the indigenous knowledge perspective (adequate references provided and opportunities were provided to the learners to engage with the information).</p>	3	<p>The educator introduced the topic to the learners. He asked two questions to the class. Then he explained the concept indigenous to the class. The class was then divided into six groups. In their groups the learners had to identify at least three indigenous plants, name three widely used medicines which were derived from the plants, and what ailments the medicines cured. Extensive reference was given to the indigenous perspective.</p>
	C. Organize/ process the	<p>1. No opportunity was given to the learners to compare the two</p>	1	<p>The lesson was about indigenous knowledge and plants that were indigenous that had</p>

	perspectives by comparing them (similarities and differences).	<p>perspectives.</p> <ol style="list-style-type: none"> 2. A limited opportunity was given to the learners to compare the two perspectives. 3. Extensive opportunities were given to the learners to compare the two perspectives. 		<p>medicinal uses. The entire lesson was from an indigenous perspective. No reference was made of the western scientific perspective. Therefore no attempt was made by the educator to compare the two different perspectives.</p>
4. Reflect.	A. Consider the consequence of each perspective (e.g. consequences of following only a western or indigenous perspective.	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the lesson ended after information on each perspective was given). 2. A limited opportunity was given to the learners to consider the consequences of the respective perspectives (e.g. the teacher simply verbally referring to the consequences of each perspective with no notes or discussion) 3. Extensive opportunities were given to the learners to consider the consequences of the respective perspectives (e.g. clear notes and learners engaged in meaningful discussion). 	3	<p>The lesson started with the teacher asking questions on the learners' understanding of the concept indigenous. The teacher then explained the definition of indigenous. The class was then divided into groups. In their groups the learners had to identify at least three indigenous plants, name three widely used medicines which were derived from the plants, and what ailments the medicines cured. After twenty minutes of discussions in their groups the learners had to report back their answers to the rest of the class. When the learners reported back to the rest of the class a discussion followed amongst them. In this manner the learners engaged in meaningful discussions.</p>
	B. Consider the concept or issues from a synthesis of perspectives (shows that each perspective is useful and that	<ol style="list-style-type: none"> 1. No opportunity was given to the learners to synthesise the two perspectives. 2. A limited opportunity was given to the learners to synthesise the two perspectives (e.g. the teacher informs the learners about the 	1	<p>The lesson was only from an indigenous perspective. No opportunity was provided to the learners to compare the two perspectives.</p>

	knowledge of each makes for a better understanding and application of the topic/concept.	importance of synthesizing the two perspectives). 3. Extensive opportunities were given to the learners to develop their own understanding of the importance of synthesizing the two perspectives).		
	C. Consider the concept in view of values, ethics, and wisdom (e.g. is the teacher making any attempt to highlight the values and ethics associated with each perspective?)	1. No attempt was made to highlight the values and ethics associated with each perspective. 2. A limited attempt was made to highlight the values and ethics associated with each perspective. 3. Extensive opportunities were given to the learners to highlight the values and ethics associated with each perspective.	1	The educator introduced the topic. By means of the question and answer method the educator sought information on what the learners knew about the topic. The class was then divided into groups. In their groups the learners discussed three indigenous plants as well as their medicinal uses. The groups then reported back to the rest of the class. The teacher did not highlight the values and ethics associated with the perspective.
5. Evaluate the process.	A. Has the teacher checked whether there has been a shift in opinion about the two perspectives?	1. No attempt was made to check whether there has been a shift in the opinions about the two perspectives. 2. A limited attempt was made to check whether there has been a shift in the opinions about the two perspectives (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether there has been a shift in the opinions about the two perspectives (e.g. the learners are engaged through class/group discussion or group/personal	1	The entire lesson was about the concept indigenous knowledge and the medicinal uses of indigenous plants. Not once during the lesson did the teacher mention about the western scientific perspective. The educator did not check if there was a shift in opinion about the two perspectives.

		questionnaire).		
	B. Has the teacher checked how the shift in opinion would inform future actions (e.g. consider home remedy or western perspective when appropriate)	<ol style="list-style-type: none"> 1. No attempt was made to check whether the shift in opinion would inform future actions. 2. A limited attempt was made to check whether the shift in opinion would inform future actions (e.g. the teacher asks a few learners). 3. Extensive opportunities were given to the learners to check whether the shift in opinion would inform future actions (e.g. learners engaged by involving them in an activity or the teacher invites them to make a decision based on an appropriate scenario). 	1	As mentioned in the previous section, the educator did not check whether there was a shift in opinion about the two perspectives. Therefore the teacher could not check whether the shift in opinion would inform future actions.

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